THE JOURNAL

OF THE

QUEKETT MICROSCOPICAL CLUB.

VOL. III.

1872—1874.

W. H. O. I.
WOODS
HOLE,
MASS.

London:

[Published for the Club,]

BY

ROBERT HARDWICKE, 192, PICCADILLY.

G. P. BACON, PRINTER, LEWES.

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Observations on the Polyzoa.

By A. H. H. Lattey, M.R.C.P.*

(Read October 27th, 1871.)

Amongst the vast number of animated beings, of whose very existence we should have remained in profound ignorance, were it not for the invention of the microscope—so justly termed a sixth sense—few afford more beautiful or interesting objects for our contemplation than the group to which the name of Polyzoa has been given; so called from two Greek words—polus (many) and zoon (animal)—being always found aggregated together in masses, and many of them resembling minute plants, so much so as to have been classed, by early observers, amongst the members of the vegetable kingdom. Their complex organization has obtained for them a high position in the animal kingdom, and the exquisite form which some of them possess cannot fail to excite our admiration. When, for instance, we see the elegant Sertularians, projecting like fairy ferns from the side of a rock-pool, attractive by their graceful forms, even before the microscope has revealed the beautiful little creatures studding their branches like living flowers, or the Polyzoary of the Halodactylus, with its exquisite bell-shaped creatures emerging, one by one, from the jelly-like mass coating the seaweed, like the ribs of a folded umbrella, stripped of its covering, and then gradually expanding into a beautiful bell, the ciliæ fringing its ribs, or tentacles, in perpetual motion, keeping up a constant eddy in the surrounding water, so as to bring the floating particles of nutritious matter within the grasp of their open mouths.

* Communicated by Mr. T. Curteis, F.R.M.S.

Amongst all these creatures, none are more curious than the species of Bugula, called Bugula Avicularia, from its possessing those strange appendages called birds' head processes, and most appropriately so, from their very exact resemblance to the head and beak of a bird. They are attached to the margins of the cells by means of a footstalk, and each has two "mandibles;" the upper one fixed and the lower one moveable, just as in birds, and they are opened and shut by powerful muscles within the "head." A most singular and curious sight it is to watch the movements of these "objects" when a portion of the Polyzoary is viewed under an inch or two inch objective, so as to allow a number of these bodies to be in sight at once. It will then be seen that each head keeps up a continual nodding movement, throwing itself slowly back, which its joint-like union to the cell allows, at the same time gradually opening its jaws, or rather depressing the lower jaw until the mouth is opened to its full extent, and when the head has gone back as far as it can reach, it suddenly resumes its former position, the mouth closing at the same instant with a sudden snap, and entrapping any luckless animal that may be passing at the time, and then the same proceeding takes place over and over again, without any intermission. It certainly is a most singular—I might almost say ludicrous—sight to see all the avicularia within the field of the microscope practising this perpetual "snapping." The great size and apparent strength of the animals which they are capable of seizing and retaining in their grasp, must impress us with a sense of the enormous strength of the muscles which move the jaw, for they seize and retain not only small vermicules, but such large creatures as caprellæ, entomostracæ, &c.; and very curious it is to watch the writhings and struggles of one of these comparatively gigantic victims in its vain efforts to escape from the jaws of its tiny captor. Not unfrequently the captive is seized by another, or even two more aviculariæ, in other parts of its body, thus making assurance doubly sure, and so deadly is the grip, that I have never seen one of them relax its hold on the application of the medium which is fatal to themselves.

Various have been the conjectures as to the office of these "heads without bodies," and their exact function in the economy of the animal—some supposing that their office is to protect the delicate creatures over whom they mount guard from the rude contact of foreign bodies which might injure their frail structure; but many

equally delicate animals, the Halodactylus for instance, are unprovided with any such protection. Others suppose that they are destined to entrap the passing animals, and hold them in their firm grip until decomposition has diffused them in the surrounding water, thus furnishing the creatures with a supply of nourishment; this, to my mind, appears the most feasible explanation. I have found these animals in great abundance at Ilfracombe, especially upon the rocks near the harbour, mostly depending from their under surface; the Campanularia Dichotoma in the same locality on the leaves of brown sea-weeds, and the Sertulariæ growing from the sides of rock pools at St. Leonards and Exmouth. The Halodactylus may be found in any locality where there are rocks, encrusting the stems and fronds of the common bladder wrack (fucus vesiculosus) at low water, especially during spring tides. It looks like a firm gelatinous coating of a brown colour, and has a semi-transparent appearance. When put into fresh sea water, it is seen to become gradually, as the animals emerge from their cells, overspread with what appears, to the naked eye, to be a minute white downy covering.

If it is desired to make preparations of any of these creatures, the following will be found a successful plan. Their extreme sensitiveness, and the rapidity with which they withdraw themselves into their cells upon the slightest touch or jar, makes it necessary to adopt a peculiar plan of proceeding. I would premise that before commencing operations with the Halodactylus it is desirable to cut it into the length required to fit the cell in which it is to be placed whilst the animal is contracted, as it may then be cut in any direction without injury, but when expanded it requires to be very carefully handled, as if the cells are in any way pressed or put out of shape they cannot be restored. For this reason it should be so cut as to fit the cell tightly so as to prevent its being shifted. The object is to coax the animals out of their tiny homes, and to keep them out until you can kill them. To accomplish the first object, it is best to keep them out of the water for several hours, and then to put them into fresh sea-water in any appropriate vessel. I have found a circular glass dish, such as is used for cakes of transparent soap, answer very well, as it can be put upon the stage of the microscope, and the effects of different stages of the operations watched, which is of importance. Some alcoholic spirit must now be added very gradually—spirit of wine, brandy, whisky, or gin,

it matters not which—when they will be observed to come out in greater numbers, evidently attracted by the taste of the spirit, and as it continues to be added they become evidently excited, withdrawing into their cells, and coming out again, bending about, and the ciliæ meanwhile moving in the most rapid manner. This continues for some time, until at length they begin to flag in their movements, which become more and more sluggish, the animals being apparently drunk. This is the moment to pour off the alcoholized sea-water, and pour upon them the preservative fluid, which has the desired effect of bringing out all that are still left in their cells, and gradually killing them, and it has the immense advantage of being at the same time a most excellent fluid for preserving them, so that they can remain in it. I find it of great service to let the Halodactylus lie for a considerable time in this fluid before finally putting them up, as a certain amount of deposit takes place from the sea-weed, which it is better to exclude from the cell. The preserving fluid I use is one recommended by Dr. Beale, as a modification of Thwaites', and is prepared as follows :—

Mix three drachms of creosote with six ounces of wood-naphtha, and add, in a mortar, as much prepared chalk as may be necessary to form a smooth thick paste; water must be gradually added to the extent of 64 ounces, a few lumps of camphor thrown in, and the mixture allowed to stand for two or three weeks in a lightly covered vessel, with occasional stirring; after which it should be filtered and preserved in well-stopped bottles.

[NOTICE.—Plates i. and ii., illustrating Mr. Furlonge's paper on the Flea, will be issued with the next No. of this Journal.]

On the so-called "Nerve" of the Tooth.

By T. C. White, Hon. Sec.

(*Read October 27th*, 1871.)

There is no field of microscopical investigation more pregnant with interest than that which comprises the study of the histological characters of the various elements that help to make up the sum of the animal frame. I would not in saying this seem to depreciate those other subjects in which lovers of microscopy find such delight. Micro-zoology, the physiology and structural elements of the vegetable world, and those studies having for their object the development and correction of the higher powers of our microscopes, possess their several interests, and are very important as fields of research; but I believe they will be found to pale before that study which enables us to arrive at a knowledge of those structures which build up and bind together the various organs of the human frame. A vast amount of work has yet to be done in comparing these several tissues with those of the lower animals, both as regards their embryonic condition as well as that of adult life; but it is not of comparative histology, nor of histology in its general aspect, that I would speak to-night, so much as of one particular tissue for which all present have, doubtless, at one time or another, felt a peculiar interest—I mean what is called the "*nerve*" of a tooth. Great uncertainty exists in the popular mind relative to its exact locality and nature; all know it to be a very painful subject, not to be touched upon except very lightly, and many desire to see what it is like. Now it occurred to me that it might not be altogether an uninteresting subject to bring under your notice, and while we were enabled to see what structural elements even so small a portion as this might afford for our powers of observation, it might at the same time stimulate the members of our Club generally to work out systematically the histology of the other structures of the animal frame. These fields have been well worked by others, it is true, but we reap the harvest of their labours in the many manuals on the subject with which our scientific libraries abound; but though skilful gleaners in the field of scientific investigation leave little for us to gather, yet stray facts may still

be picked up by diligent and careful, but above all *systematic* observers.

I trust that you will deal leniently with me if I presume for a moment that you know nothing whatever of the various structures entering into the formation of a tooth. I can thus, in an elementary manner, recall to your minds the osseous elements we meet with in our examination. If a tooth be divided longitudinally the main body of such a section would reveal three different substances surrounding a cavity, which, to a certain extent, partakes of the external shape of the tooth; immediately surrounding the cavity, and constituting the principal bulk of the tooth, we notice a fibrous silky substance, called the "*dentine*;" capping that part of the dentine which appears above the gum, we see the crystalline, almost insensible "*enamel*," designed to protect the highly organised and exceedingly sensitive dentine beneath it; we shall also observe that the dentine inserted in the jaw, and forming the root of the tooth, is clothed with a material of a different appearance to the other two substances—that is called the "*cementum*." Of the enamel and cementum, it is not necessary on this occasion to speak, but the important relation existing between the "nerve" and the dentine demands that I should enter more into detail in explaining its microscopical appearance. In looking at a section of dentine under the microscope in a well-developed human tooth, one is reminded of those views of the comparative sizes of the rivers of the world given in some atlases, only here our rivers are all the same diameter and about the same length, and run together in parallel waves. If, for the sake of illustration, we speak of them as rivers, we should say that they arise beneath the enamel by exceedingly fine tributaries, by the confluence of which the main stream is gradually enlarged till, flowing on towards the centre of the tooth, its "*debouchure*" helps to make up the walls of the central cavity, which is occupied in the living state by the so-called "nerve." A closer examination of our metaphorical rivers with higher magnifying powers will show us that they are tapering and undulating tubes, and existing so abundantly in the dentine as to impart to it that fibrous silky aspect which cannot fail to strike the most casual observer. These tubes, which, on the walls of the cavity, measure about $\frac{1}{10000}$th of an inch in diameter, are occupied in a recent tooth by transparent structureless fibres known as the dentinal fibrillæ, the exact office of which is but obscurely defined, but they may

minister to the nutrition and vitality of the tooth, since, when from age or disease these tubes become consolidated, the fibrous structure is replaced by one resembling horn, and, as a consequence, the tooth dies, becomes loose and a source of painful irritation. If a section of the dentine be made in a direction that shall cut across the course of these tubes, each tube will present an irregular aperture, and will be seen separated from its fellows by an almost equal proportion of intertubular tissue. We need not now consider any further the character of the dentine, as I shall have to recur to it when speaking of its relation to the nerve; but what I have laid before you will enable you to understand the meaning of much of the structure it is our especial object to examine in the central or *pulp cavity* of a tooth.

If we take a recently extracted healthy tooth and split it we shall notice that the pulp cavity is occupied by a pinkish fleshy mass about $\frac{3}{4}$ of an inch long and $\frac{1}{10}$th of an inch wide at its upper and thickest part; it partakes somewhat of the external shape of the tooth, being wide in the upper part, and tapering towards the tooth: this, then, is what is popularly called the "nerve." In physiological parlance it is termed the pulp. The basis of this pulp is composed of areolar tissue, whose interstices are filled with a homogeneous plasma.

A microscopical examination of its exterior will reveal an infinite number of small points, giving to it an appearance not much unlike the cross section of the tubes of the dentine, both as regards size and distribution. Having noticed this much, recourse must be had to compression before we can readily make out the arrangements of its internal structure. Before proceeding to flatten it by pressure it may be withdrawn from its cavity, and allowed to soak in the ammoniacal solution of carmine, recommended by our President in his book "How to Work with the Microscope;" let it remain in it twenty-four hours, wash away the carmine fluid, and transfer it to glycerine for a few hours; then put it under gentle, gradual pressure for some few hours more, when it will be rendered sufficiently thin to be easily examined by a $\frac{1}{4}$ of an inch objective or higher powers.

Commencing our examination at that part of the pulp nearest the apex of the root, we shall notice it entering the foramen of the fang as a fine thread, which though so fine nevertheless conveys the nerve and the artery into the pulp, and gives exit to the

returning vein; tracing this thread into the pulp we shall readily distinguish the nerve as a bundle of parallel fibres which, running in together a short distance, divide into two, three, or four fasciculi, and dividing again still give off fibres to every part of the pulp; it is highly probable that these fibres end in loops, but the pressure necessary to reduce the pulp sufficiently thin for observation ruptures the loops, and consequently they very frequently appear to terminate in free extremities; but one fact may be easily demonstrated, namely, their course is always at right angles with the dentinal tubuli. Besides the ramifications of the dental nerve the pulp also contains the branches of the artery and its vein; these are not so easily followed, but in an examination of the pulp of a tooth extracted for severe inflammation in it, the congested vessels were naturally injected, and could be seen as a complicated network without any definite arrangement excepting a loop-like distribution towards the circumference; in some cases the vessels of the pulp, becoming stained by the carmine, will be readily seen with their peculiar transverse nuclei and distinguishable from the areolar tissue, whose nuclei are spindle-shaped. There is one feature in the microscopical examination of this prepared pulp which will not escape observation—it is the curious arrangement of its cortical portion. In referring to the microscopical appearance of the exterior of the pulp, as it appears on first splitting a tooth, I alluded to the comparative likeness presented by it to that of the dentine cut across the tubes, and if that comparison is borne in mind in the examination of this external portion of the pulp, under its present circumstances, we may easily interpret the meaning of this arrangement. The cortical substance of the pulp in its healthy condition consists of a number of oval bodies placed side by side with their long axes perpendicular to the surface of the pulp on which they stand; they are deeply stained by the carmine, which proves that they are endowed with active and growing powers. These oval bodies are termed "*Odontoblasts.*" An examination of an odontoblast, which has been isolated by pressure from the others, will show that it has an attachment by a transparent structureless appendage to something within the body of the pulp, while a similar appendage, proceeding from its distal extremity, penetrates a tubule in the dentine, and becomes the dentinal fibril of Tomes.

The odontoblastic layer of the pulp is so important an element in the life and histology of a tooth that its history deserves a closer

examination than the limits of a paper like this can afford; but it may be interesting to show the part it plays in the formation of the dentine.

About the sixth or seventh week of embryonic life a groove is formed in either jaw, at the bottom of which, after the lapse of a few weeks, papillæ begin to arise, and shortly after transverse partitions in this groove shut off and separate each papilla, which then becomes the representative of the future temporary tooth. About the seventh month of fœtal life the ossification of the tooth commences, and the dentine is represented by a cup-shaped scale capping the crown, and ultimately extending down the sides and embracing the whole of the upper surface of the pulp. It is at this period of their growth that the odontoblasts are most active, for they have the development of the dentine before them, and deriving a plentiful supply of nutrition from the plexus of bloodvessels beneath them, dentine is formed through their agency from without inwards, till the pulp being reduced to the size at which we generally see it by the gradual formation of the dentine, the odontoblasts become dormant, but capable of awaking to activity under the influence of certain circumstances of irritation; thus if caries attacks a tooth at a particular spot the tubuli in the dentine, through the fibrillæ in them, become consolidated at an equal distance from the point of attack all round it, and a barrier seems to be thus thrown up against the inroads of the advancing enemy; but unless such a remedial measure as the careful excavation of the carious portion of the tooth and subsequent plugging of the cavity be adopted, barrier after barrier may be thrown up but to be overcome. Even then the odontoblasts of the pulp resist by forming new dentine in its very substance, and it is only when inflammation and suppuration destroy the odontoblasts that this reparative process is annihilated. In some cases of general irritation of the pulp, as where the crown of a tooth is worn through by the grinding down and wear of mastication, the whole of the pulp may be converted into an irregular dentine. Sometimes nodules of ossific matter are found in the meshes of the areolar tissue of the pulp, but these do not partake of the character of the dentine, but are semi-transparent and structureless, testifying to the amount of bone-producing matter in the homogenous plasma saturating the body of the pulp, but which it is the legitimate office of the odontoblasts to build up as dentine.

There are great and, I fear, almost insuperable difficulties in the way of clearly seeing the termination of the nerve fibres in the pulp ; one can only conjecture at the method in which they end. In some specimens two fibres may be seen running side by side for some distance, and when you expect to see a loop the ends are found separated ; this may probably arise by the pressure used to render the pulp thin enough for observation. Some specimens, again, show a very apparent looping of the fibres, but the loops extend round the circumference towards the end of the pulp, they are so large ; but in no case have I met with fibres that would lead us to suppose that were they small enough to enter the tubuli that they do so. How, then, are we to account for the painful sensation experienced in cutting into live dentine, unless we suppose that a connection of some kind exists between the tubuli and the fibres of the nerve ? The only theory that can be suggested is that the dentinal fibre contained in a tube of the dentine passes out through its odontoblast, and then, becoming fused with the nerve, conveys the sensation to the brain, and we are conscious of the irritation.

I have not found it possible to see this connection between the odontoblast and the nerve fibres, because the re-agents usually employed to render nerves visible, dissolve away the odontoblasts ; neither have I, by means of thin sections, been more fortunate, as the proximal caudal appendage of the odonto blast is too transparent and too minute to admit of demonstration, except, perhaps, by the employment of new re-agents ; in specimens of the pulp, that after staining with carmine have been teased out with needles, the isolated fibres have had, besides their own coloured nuclei, coloured odontoblasts, with this internal caudal appendage fused into their outer parts. Such may be the general mode of their connection, but I am not clear on that point. Such, then, are a few of the principal elements met with in a microscopical examination of what is popularly termed the "*nerve*" of a tooth, but in case any member present may feel inclined to work out these details for himself, it may be as well to append a few remarks relative to the plans of investigation, attended by the best results. The teeth employed have been temporary teeth, removed in a healthy condition, to make room for the advancing permanent set, any others being unsuitable from disease. It is necessary to exercise great care in extracting the pulp from them, as the bone dust from the

tooth and impurities of various kinds cling most tenaciously to the odontoblasts, and not only obscure the view of the delicate details, but look unpleasant and slovenly. The plan found to answer best is to file a longitudinal groove round the tooth; then, having washed away all the *débris* very thoroughly, split the tooth with a pair of wire nippers, when it will come clearly in two and expose the pulp for its whole length, when it may be withdrawn by seizing it at its smallest part and tearing it out of the cavity. This will draw out not only the odontoblasts but some of the dentinal fibres attached to them. Another very good plan for observing the relation of the pulp to the dentine is to soak the tooth for a few weeks in the carmine staining fluid, which becomes sucked up through the foramen of the fang, and being absorbed by the pulp, colours it completely. The tooth may then be decalcified by immersion in ordinary hydrochloric acid, which removes the lime but does not hurt the soft tissues. At the end of a fortnight the tooth may be cut in thin slices, when the pulp will be cut with the decalcified osseous tissue, and the relation will be well shown. I have thus, in these few brief remarks, which fail to do justice to my subject, endeavoured to show you that that which is generally called the nerve of a tooth is in reality a mass of areolar or connective tissue, through which ramify the nerve, vein, and artery destined for the life of a tooth, that its function originally was the formation and building up of the dentine, that its powers in adult life remain dormant, but capable of being aroused under the action of a stimulating influence to develope dentine again, and that it performs an important part in ministering to the vitality of a tooth, as well as constituting a tooth a very delicate sensory organ. These few remarks, therefore, will, I hope, have the effect of inducing others to take up the comparative histology of the pulp, and lead them to investigate its tissues in some of the lower animals, both in their fœtal condition and at maturity, and I can promise them a rich reward in return for their labours in new fields of observation open, and fresh revelations of the skill of the Great Architect of All.

On the Internal Structure of the Pulex Irritans.

By W. H. Furlonge.

(*Read February 23rd*, 1872.)

Before entering upon the subject of the second portion of my communication on the Pulex irritans, viz., its internal structure, I think it desirable to state, that I have not been able to resort to actual dissection of the insect, in aid of my observations. In fact, it appears to me, that such extraordinary manipulatory skill would be required to dissect so minute a creature, that any attempt to accomplish such a task, would prove almost abortive, even to the most practised eyes and fingers. Fortunately, however, such is the transparency of the chitinous envelope of the insect, that it is possible to observe every organ, almost as perfectly as if enclosed in glass, even when employing such comparatively high powers as the $\frac{1}{4}$in. Nevertheless, I have been obliged to leave wholly untouched some portions of the internal structure of the animal, such, for example, as the nervous system, and several of the glandular organs, and I shall be greatly pleased if other workers, of greater anatomical skill, will shortly fill up the gaps I have left in this investigation.

The internal structure of the flea may be conveniently described under the following heads: the alimentary and digestive system with the organs pertaining thereto, the respiratory system, and the reproductive organs.

1st.—*The Alimentary and Digestive System.*

In my previous paper I have stated that I regard the commencement of the alimentary canal as a slender fleshy proboscis, perforated by a canal, through which the blood is *sucked* directly, and very rapidly, into the first stomach by the constant powerful muscular action by which the insect is enabled to dilate its external envelope. In the course of my investigations I have had occasion to preserve individual insects alive for weeks together, and, therefore, to feed them, and thus I have had very numerous opportunities of observing the process of imbibition. My method of procedure was to keep the insects in a corked test tube, and when it was desired to feed them, I inverted the tube upon my wrist or forearm. The creatures almost instantly fastened on the flesh, and usually

stood on their heads, as it were, plunging their mandibles deeply into the epidermis, at the same time rapidly and powerfully dilating their bodies by alternately shortening and elongating them; and I may observe that I have never been able when feeding my captives to detect the slightest prick or wound from the insertion of their mandibles. In the course of two or three minutes, the first stomach becomes gorged with blood, and if the insect is permitted to remain undisturbed, the blood passes on to the second stomach, presently to be described, the animal emitting jets of dark and semi-digested blood from the anal orifice with such force as sometimes to project the contents of the second stomach to a distance of one or two inches.

In examining the position and structure of the alimentary and digestive organs, I have found it desirable to select a young and transparent male specimen, as from the absence of the ovaries, and the partially matured eggs which are generally to be found in the female, the course of the digestive canal is more clearly seen. A suitable specimen being found, it is to be kept for about two days without food, then fed in the manner I have described, but not permitted to remain on the skin for more than a minute, when it is to be removed and stupefied by the insertion within the test tube of a morsel of blotting paper containing a very small quantity of chloroform, when it may be placed in the compressor, and gently flattened between the glasses by a very gradual tightening of the screw.

When viewed under such circumstances in a good binocular with a $\frac{4}{10}$ths objective, by transmitted light, and especially by dark ground illumination, the sight is extremely interesting, and, I think, very beautiful. The first stomach filled with the bright crimson freshly ingested blood is seen to be undulating incessantly in the manner I attempted to depict by the dotted lines in the drawing of the Pulex exhibited in the reading of my last paper, and since engraved in our Journal. This energetic peristaltic movement—amounting in fact to a violent churning action—of the stomach, sometimes proceeds from the anterior extremity, undulating backwards, and sometimes the wave originates and proceeds in the reverse direction, as many as two or three waves being often seen in progression at the same time. By this churning action the blood is regurgitated violently backwards and forwards in the stomach, and is, as I think, in this way brought into contact with the gizzard, a very interesting organ presently to be described.

The first stomach of the flea possesses a very remarkable structure. It is, in proportion to its size, of extraordinary thickness and muscularity; in fact, it is so banded and cross-banded by thick muscular fibres running in all directions, that it presents the appearance of a reticulated structure; indeed, under the $\frac{1}{4}$in. objective, when filled with blood it resembles nothing so much as a closely but irregularly knitted purse of thick crimson silk. It is, no doubt, by the powerful contraction of these muscular bands, that the violent movements I have described are maintained. Pl. i., Fig. 1 shows the appearance of the structure of the stomach as magnified 200 diameters.

The Gizzard.—Situated at the anterior orifice of the stomach, immediately behind the entrance of the canal, which conveys the blood from the suctorial proboscis, may be observed a dense semi-opaque muscular organ, in shape similar to an ogival-headed shell, the conical end being projected forwards, and receiving the extremity of the suctorial canal, the orifice of the stomach surrounding its base. By careful illumination with a strong light, the structure of the gizzard may be made out to consist of a dense and very thick substance, surrounded by a reticulation of muscular fibres, somewhat similar to those of the stomach, but the meshes, so to speak, being more close and regular. In the living insect this organ is generally to be seen in constant movement (if the specimen is not too much compressed) elongating to about twice its normal length, and then suddenly contracting, and at first sight might be taken for a heart, or blood-circulating organ, so constant and regular are its pulsations in some cases. In reality, however, it is a gizzard, by means of which the blood corpuscules are ground up or disintegrated until fitted for digestion in the second stomach.

I have in this place the pleasure of mentioning a somewhat curious circumstance of peculiar interest to the Club, as it relates to the distinguished man from whom we derive our name—the late Professor Quekett. I am indebted to Mr. Parkes, of Birmingham, who enjoyed the privilege of his intimate acquaintance, for the following anecdote :—In a discussion upon the structure and functions of the digestive organs of insects, it was observed in the presence of Mr. Quekett, that suctorial insects are not furnished with any gizzard or grinding apparatus, such organs being, in fact, unnecessary for the assimilation of their food. While assenting to the general proposition, however, Mr. Quekett, with the sagacity he

possessed in so remarkable a degree, maintained that in the case of the flea a gizzard *ought* to be found, as, in his opinion, some such apparatus would be requisite for the purpose of breaking down the blood discs and preparing them for assimilation. It was not until some time after the death of Mr. Quekett that the actual existence of the organ he had predicated was demonstrated, the flea's gizzard having been dissected out and isolated for the first time, I believe, by Bourgoyne, of Paris. We must regret that the Professor did not live to see the truth of his conjecture thus confirmed.

More skilful fingers than my own have enabled me to figure the accompanying drawing (Fig. 2), which has been taken from a preparation by Mr. Topping. With admirable skill this minute portion of the insect's structure has been isolated, and laid out upon the glass slide. It will be seen to possess the well-defined and powerful muscular structure common to the gizzards of insects, though the teeth or rasping appendages usually found in such insects as feed upon hard food are wanting. In the flea's gizzard, however, such aids would have been clearly unnecessary, the breaking down of the blood corpuscules being, as is easily conceived, rapidly and perfectly accomplished by the passage of the food between the rubbing surfaces of the organ when actuated by its powerful muscular bands.

The Second Stomach, or Intestinal Sac.—The blood constituting the animal's food having been thus triturated, passes on through a comparatively short and straight gut or intestinal canal, which is furnished at its junction with the posterior extremity of the stomach with a powerful sphincter muscular valve, controlling the passage of the food, into the digestive sac or second stomach, as it may be termed. In most specimens of the insect that I have examined, the capacity of this sac seems to be almost, if not quite, as large as that of the first stomach. The second stomach, like the first, is subjected to constant dilations and contractions, but these do not occur in waves or undulations; in fact, the sac being sub-globular in form, and not elongated, like the first stomach, its contractions are necessarily accomplished in a different manner. Moreover, the walls of the sac are not themselves muscular, and therefore its movements are not produced by the contractions and dilations of the parietes themselves, but by the agency of muscular bands attached to them, which are set in action at different times, and seem to *pull* the walls of the sac together, from side to side, by which movements the fluid

contents of the sac are kept in a state of constant motion, though much less violently than those of the first stomach.

The Rectal Papillæ.—Within the intestinal sac are suspended six curious conical teat-like organs, shown in Fig. 3. These organs will be at once recognised by those who are familiar with Mr. Lowne's work on the "Blow-fly," as the rectal papillæ, or urinary organs of the insect. I must, indeed, candidly say, that but for Mr. Lowne's observations, it is very possible that the existence of these organs in the flea would have escaped my notice, as, owing to the generally dark colour of the semi-digested contents of the sac, these organs are not very readily discernible. When one knows what to look for, however, and where to seek for them, they can generally be made out very distinctly after a little patient focussing. The rectal papillæ are then seen to be glandular organs, composed of a soft fleshy substance of a light yellow colour, having the form of elongated cones, the bases of which are flat or very slightly rounded. Into the centre of the base of each of the papillæ there enters a small tracheal tube which passes nearly to the extremity of the organ, where it bifurcates and turns backwards, terminating in very numerous and exceedingly minute fibrils, which permeate the entire substance of the organ. Similar delicate fibrils are also given off laterally from the main tracheal filaments in its course through the organ, radiating from the centre to the circumference, and ramifying in all directions throughout its structure. The external surfaces of the papillæ appear to be perfectly smooth, and I have been unable to make out the existence of any pores or orifices, except perhaps close to the extremities, where the surface seems irregular or warty, and I fancy that on one occasion, when examining a specimen under peculiarly favourable conditions, I was enabled to make out, with the $\frac{1}{4}$in. objective, about 10 or 12 orifices at the conical extremities of each of the papillæ, and, in point of fact, there can be no doubt that some such orifices must exist whether I have been able really to see them or not. The tracheal vessels which supply the six papillæ all spring from one tracheal tube external to the intestinal sac, the branches from which pass through its walls and serve to support the papillæ as they hang freely suspended within the sac. It is very interesting to watch the constant movements of these long conical finger-like papillæ crossing and gliding over each other as the walls of the sac are pulled to one side or the other by the external muscles.

The posterior extremity of the digestive sac is connected either directly, or by a very short canal, with the anal orifice which opens just behind the pygidium.

Having thus described the structure of the alimentary and digestive canal, and the organs pertaining to it, so far as I have been able to make them out, I will now briefly recapitulate my views of their functions.

The blood as ingested passes directly to the first stomach, which appears to perform the office of *a crop*, or receptacle for the food. In this organ it is, as we have seen, kept in a state of violent agitation, and is, I believe, constantly regurgitated into the gizzard, where it is submitted to the action of the corrugated rubbing surfaces of that organ, the blood corpuscules being thus broken down. From time to time, portions of the contents of the first stomach are expelled through the valve at the posterior extremity of the stomach into the intestinal canal, connect'ng the two stomachs. I may observe, in parenthesis, that I have frequently had an opportunity of observing this passage of the contents of the first stomach into the second, and that the successive portions of the contents thus transferred, never rested in the connecting intestinal tube or gut, which is always empty except at the moment when the food is passing through it into the second stomach. It is possible that some portion of the blood may be taken up by certain *quasi* absorbent vessels with which the canal is seen to be lined, even in the course of the rapid passage I have described, but without doubt the chief portion of the assimilative process takes place in the second stomach. This appears to be proved by the fact that when the insect is permitted to gorge itself with food, it will, as already noticed, fill both stomachs with blood, and, of course, the contents of each will present precisely the same appearances under the microscope; but after the digestive process has gone on for some time, the contents of the second stomach (which, in the first instance, very speedily assume an opaque dark brown colour) become progressively lighter in tint, until at length the contents of the sac appear to consist of a limpid fluid of a light red or pink colour, in marked contrast with the deep crimson colour of the contents of the first stomach, which, I may remark, almost always retains its crimson colour so long as it remains in that organ. When the food has been so far digested, the insect emits small portions of the contents of the sac from time to time, as excreta, to make room for portions

of fresh blood from the first stomach; but, as before mentioned, when the creature has the opportunity of taking in an unlimited supply of food, it has the power of expelling the whole contents of the sac, which then becomes filled with fresh blood. This power of ejecting the contents of the second stomach in whole or in part at the will of the animal, explains the manner in which the female insect is enabled to make provision for the sustenance of the larva, when it emerges from the egg, as originally observed by the late Richard Beck, by emitting portions of semi-digested food in small drops which immediately coagulate and form the food of the larva when hatched.

The Respiratory System.—We now pass on to the consideration of the organs of respiration, and I may premise by observing that I know of no creature in which the typical respiratory system of the insecta can be so admirably seen or so conveniently studied as in the Pulex. Mr. Lowne correctly remarked in the course of his observations upon my last paper, that when a living flea is immersed in glycerine and examined by reflected light, its tracheal system appears as if injected with mercury. But I think it may be even more beautifully shown, and certainly more advantageously studied, by transmitted light under the $\frac{1}{4}$in. objective. Selecting a young and transparent specimen, which, for the purpose of observing the tracheal vessels to the best advantage should be kept without food for about 48 hours, in order that it may be compressed somewhat powerfully without injury, the employment of the $\frac{1}{4}$in. objective reveals a structure of extraordinary beauty and wonderful complexity. I have attempted in the accompanying drawing to delineate the general form and course of the main tracheal vessels of the abdominal system, but it is simply impossible for the most accomplished and careful artist to do full justice to the subject, and the drawing now shown has no pretensions to be more than a mere sketch, simply intended to illustrate the description I am about to offer.

The principal portion of the respiratory system of the flea is seen to consist of two main tracheal vessels running along the entire length of the abdomen, just beneath the chitinous envelope on each side, and passing, as will be afterwards shown, into the thorax and head. At the posterior extremities, the upper and lower main tracheal vessels unite and communicate with those remarkable and very large trumpet-mouthed spiracular orifices, described in my previous paper as situated beneath the margins of the plates sur-

rounding the pygidium, and opening on either side just in front of that organ. These large spiracles, in fact, appear to be the principal orifices by which the main tracheæ are supplied with air. The lower main tracheæ communicate with the external air by means of short branches, which, rising vertically, cross the upper main trachea, and terminate just beneath the cup or funnel-shaped extremities of the round spiracles, described in my former paper as situated along the line of the abdomen.

It is very remarkable that there appears to be a complete break, or solution of continuity, between the extremities of all those spiracular orifices, and the tracheæ which they supply, with the exception of one or two turns of the wire-like spiral fibre supporting the parietes of the tracheal tubes, and which may be seen to pass from the spiracle to the tracheal tube. I have endeavoured, by the use of very high powers and careful illumination, to comprehend this curious peculiarity of structure, and I have satisfied myself that there exists a very thin transparent membranous envelope, surrounding the tracheæ, and that at the points of junction with the extremities of the spiracles this membrane is expanded into a sort of bag or corrugated sac, as shown in the drawing, the obvious purpose of this method of union being to permit the flexure of the animal's body in every direction, without danger of rupturing the delicate tubes connected with the external spiracles.

The lower main tracheal vessel (B) presents the appearance of a series of loops* hanging down between the tubes which communicate with the abdominal spiracles, and from the lower or convex sides of these loops a series of large tracheal vessels descend perpendicularly, one of these vessels running downwards on each side of every segment of the abdomen. From these large vessels, as also from all parts of the main trachea, proceeds a wonderfully complex system of minor vessels, ramifying in every direction, and proceeding to every portion of the animal's organism in a series of filaments constantly decreasing in diameter, the ultimate fibrils being so minute as to demand the highest powers of the microscope to resolve, and yet the smallest of these vessels exhibits its characteristic spiral structure as perfectly as the largest of the main tracheæ.

* It is proper to state that the so-called loops of the lower main tracheal vessel are shown much flatter than they are in reality. This is due to the distortion arising from the compression of the insect, which has the effect of elongating or *stretching* out this system of vessels. In their natural position the loops are much deeper and are closer together than is here depicted.

At the second abdominal spiracle, the two main tracheal vessels unite anteriorly and join the large trachea, which descends perpendicularly from the first spiracle, and thence, from a little above the point of junction, a large vessel—of course on each side of the animal—proceeds into the thorax and head, supplying the smaller vessels, which ramify from them to the various organs contained in these portions of the body of the insect.

I have here to refer to the pair of erectile spiracles mentioned in my former paper as situated in the epimeron of the mezo-thorax. It may be remembered that I described these as round dome or nipple-shaped prominences, capable of protrusion and retraction, and which, in fact, in the living animal are in a state of continual movement. Tracheal vessels may be distinctly traced as being in connection with and supplied by these erectile spiracles, and since the reading of my previous paper I have satisfied myself that the protrusion of these organs is not, as I believe was suggested, due to the compression of the insect while under examination, but that they normally present the characteristics I have described. I may add that though I have not been able to make them out, I confidently anticipate that similar pairs of spiracles exist in each segment of the thorax, and I would invite the assistance of some of our working members in searching for them. My reasons for this conjecture will be stated presently.

I also desire to refer to the remarkable sacs which I described as existing in the upper tarsal joints of the third pair of legs, and which I at that time considered to be contractile sacs. It may be remembered that Mr. Lowne demurred to this view of their structure, and gave it as his opinion that these so-called sacs are really expansions of the tracheal vessels supplying the limbs. I think it right to say that I have since ascertained that Mr. Lowne's view is correct, and I now exhibit one of these tracheal enlargements carefully laid down by the aid of the neutral tint reflector. (Fig. 4.) I was led into the error of considering these vessels muscular sacs, from the fact of their rhythmical contractions, which I supposed to be accomplished by muscular bands, for the striations of which I mistook the spiral fibrous structure of the tracheal vessel itself. But while I admit the error into which I was betrayed, as to the structure of these so-called organs, I must adhere to the views I expressed as to their use and office, viz., that by the rhythmical compression of these tracheal enlargements—however that

is accomplished—the air is *forced* through the infinitely less than capillary ultimate fibrils of the tracheæ, and in this opinion Mr. Lowne coincides.

I am now brought to a few suggestive remarks which I desire to offer upon the functions of the wonderful respiratory apparatus just described, as a whole.

The problem to be solved is, in what way does this apparatus act in maintaining a constant and regular circulation of air through every tube and fibril of the air system? It has been suggested that inspiration is accomplished by the dilation of the abdomen by voluntary muscular action, and conversely, that expiration is effected by corresponding muscular compression. But I would ask, is it by any means an ascertained fact that the air inspired through the abdominal spiracles is expired through the same orifices? I cannot venture to assert positively that it is otherwise, but I strongly incline to suspect the probability that the air inspired through the abdominal spiracles may be expired through the spiracles of the thorax. The appearance and apparent action of the so-called erectile spiracles of the thorax seems, to my mind, to lend support to the idea, and it is from these considerations I have been led to suppose that similar spiracles will probably be found to exist in the other segments of the thorax.

I put these views forward as purely suggestive, and with the hope of promoting enquiry and *work*, in a most important and interesting department of insect structure, upon which, I believe, our knowledge at the present time is very limited; and I cannot help thinking that a collation of the knowledge possessed and a comparison of the opinions entertained by individual members of our Club could not fail to throw much light upon the subject. I shall be very glad if the expression of these hypothetical views has the effect of inducing such a discussion, even should the result be (as is, indeed, very likely) to demolish the conjectures I have formed. May I be permitted to say that discussions of this character, conducted in the spirit of simple investigation and search for truth amongst our members, would infallibly result most beneficially to the progress of knowledge in those branches of science which we are incorporated for the express purpose of promoting.

The Reproductive System.—The structure of the reproductive organs of the female flea is comparatively simple; that of the male is exceedingly complex and remarkable.

I shall first describe—

The Female Reproductive Organs.—The posterior lower abdominal plate of the female flea is elongated or produced on either side so as to form a V shaped recess projecting for some little distance beyond the body of the insect (Fig. 5). These lateral projections, as we shall afterwards find, serve an important purpose during the congress of the sexes. From the margins of these plates a fringe of thick bristly hair projects inwards. The lower terminal portion of the fleshy part of the abdomen projects between these lateral plates, and upon its under side is situated a circular orifice fringed with two rows of short hairs projecting inwards and outwards. This orifice opens into a somewhat elongated vaginal canal, the direction of which is upwards and forward. In the unimpregnated insect, grape-like clusters of ovaries may be seen dependant from the walls of the enlarged extremity of the vaginal canal, through which, as will be afterwards seen, the male organ passes for its entire length, thereby bringing the seminal fluid into direct contact with the ovaries. After impregnation the walls of the ovarian cavity distend enormously, so as to contain from six to ten exceedingly large eggs, relatively speaking, which, when fully matured, appear to occupy more than one half of the capacity of the entire abdomen. The eggs of the flea are matured with great rapidity, and are produced at the rate of five or six per diem, when the insect is in a state of captivity; but I have reason to believe that under natural conditions they are produced even more abundantly. I have not had opportunities of observing the development of the eggs in the ovaries from the time of impregnation to maturity, this being one of the points I have been obliged to leave unworked.

The Male Reproductive Organs, so far as I have been able to make them out, may be considered as consisting of three principal parts—

a. The prehensile organs and their sheath plates.
β. The sheath of the penis.
γ. The penis.

Referring to Fig. 6, it will be seen that the inferior terminal plate of the male flea is elongated so as to form a deep cavity. On either side of this cavity are situated two rounded concavo-convex plates of chitin, somewhat thicker in substance than those enveloping the abdomen, but striated in a similar manner, the margins of

which are thickened and fringed with curved bristles projecting backwards. In their normal position these plates incline inwards towards each other, the convex sides being outwards, so that their fringed margins unite and form a ridge or crest, rising very little above the edges of the cavity, and completely closing the opening in which they are placed. These sheath plates gradually taper downwards like leaves, and terminate in stout short stalks, which are attached to curved chitinous bands similar to those afterwards to be described as moving the sheath of the penis. When these organs are in action they are pushed backwards and upwards, and assume an erect or nearly parallel position, as shown in the figure. This movement is accomplished by means of appropriate muscles attached to the chitinous processes just described.

The Prehensile Organs (Fig. 7) consist of a pair of strong claws, or nippers, situated within the concave sheath plates, to the stalks of which they appear to be attached, so that when the sheath plates are extruded the forceps come up with them. These organs strikingly resemble the terminal joints of the large claws of the lobster, excepting that one of the extremities of each is broad and square, while the other is bluntly pointed. They are composed of chitin of a deep reddish-brown colour, and appear to be solid or homogeneous in structure, and although attached to the stalks of their sheath plates, they are capable of independent movement in a manner precisely similar to that of the analogous terminal joint of the lobster's claw. I may observe that one of the plates, with its accompanying forceps, is sometimes extruded or retracted sooner than the other, though they generally move in unison.

The Sheath of the Penis.—When the plates and forceps have been protruded the sheath of the penis begins to emerge between them, and finally assumes a position nearly erect, or slightly curving backwards, which, it may be remembered, was shown in the large drawing of the male pulex accompanying my previous paper. The sheath possesses a very remarkable structure. It consists of a fleshy organ, relatively of very considerable size, which is surrounded for about two-thirds of its circumference by a very thin, polished, curved plate of chitin, which serves to sustain the fleshy organ within, the posterior portion of which projects beyond the edges of the investing plate.

At the extremity of the organ, which is triangular in section, the terminal edges of the chitinous plate are capable of being drawn

inwards by the retraction of the fleshy organ to which it is attached forming flaps, of an inverted V shape, as shown in Fig. 10, or they may be expanded or opened out in a most extraordinary manner, presenting a notched or *embattled* outline or margin, in which position it is seen to be furnished with three curved spines, as shown in Fig. 9. The contraction and opening out of the extremity of the organ are accomplished very suddenly, and with considerable force.

The opposite or inferior extremity of the sheath is connected to a pair of bands, or rather rods, of dark brown chitin, which curve upwards and then backwards into a coil of several turns, like a spring, as, in fact, there can be no doubt is precisely the purpose which these curved and coiled rods really serve, extruding the penis sheath by uncoiling, and retracting it by the opposite action, the coiled state being the normal position of the rods.

The Penis.—Looking down upon the extremity of the extruded sheath, when expanded, a minute orifice may be observed through which the penis is projected. It is a dark-coloured, wire-like organ—presumably chitinous—which is capable of protrusion for about half the length of its sheath; but of its structure I can give no further description; in fact, I have only seen the extrusion of the organ in some four or five instances out of the dozens of male fleas I have had under observation, and on these occasions it was protuded and retracted with such rapidity that the eyes could hardly follow it. I have no doubt, however, that it constitutes one of those coiled rods or chitinous fibres just described, and that it is projected by the uncoiling, and withdrawn by the release of the spring-like coil. I have been entirely unsuccessful in my attempts to distinguish the spermatic vessels of the male pulex, unless they may be certain glandular organs filled with transparent globules, situated around the spiral coil; but it is difficult, if not impossible, to distinguish any difference in structure between these and the ordinary fatty globules abundantly found aglomerated together in many parts of the internal organs.

Having now described the organs of reproduction, it remains to describe their office. The first action is the extrusion of the sheath plates and forceps. These latter grasp the plates which, as already described, project on either side of the extremity of the abdomen of the female, and thereby the male is enabled to take firm hold of the female insect during copula. The extrusion of

the sheath of the penis then takes place, which next passes into the vaginal orifice.

I have repeatedly witnessed the copula of the insects, and though I have before referred to the pulex as an animal in which the typical structures and functions of the organs of insects can be studied under singularly favourable circumstances, I may here remark that in no description of investigation are these exceptional advantages so great as in the study of the reproductive process. When young and transparent specimens of the insect are selected this important process can be seen with remarkable clearness, and the animals being so closely locked together may be manipulated with great facility. Even when placed between the glasses of the compressor they will endure an amount of compression quite sufficient to render the abdomen of each insect perfectly transparent without the interruption of the copula. When thus examined the extremity of the sheath of the penis may be seen to be continually opening out and closing up, and by this action the spinous processes attached to the extremity of the sheath appear, as it were, to *grasp* the ovarian clusters I have described; but I have not been able to observe the protrusion of the penis itself during the copula, nor at any time to distinguish spermatozoa in the female.

I would strongly urge that the members of the Club should repeat these observations, when probably much more than I have been able to make out would be discovered in this important department of insect physiology. It is by no means a difficult matter to induce copula in the pulex. In general it suffices to keep the male and female in separate tubes for a day or two, then to feed them, and afterwards to put them together. In most cases copula immediately ensues. Easy as it is, however, to make the observation, I have never yet met with any microscopist who has witnessed it, with the exception of one fellow worker, Mr. McIntire, whose observations on the subject exactly confirmed my own. If he should happen to be present at the reading of this paper he will, perhaps, give the Club the benefit of his observations upon the subject.

I had intended to have closed my paper with a description of the development of the egg through its transformations into the perfect insect, but I fear I have already trespassed upon the patience of the Club too much; I hope at a future period, however, to read a short communication on this concluding portion of the life-history of the Pulex Irritans.

PROCEEDINGS.

December 8th, 1871.—Conversational Meeting.

The objects exhibited were:—

Muscular Fibre	Dr. Ramsbotham.
Melicerta ringens	W. H. Golding.
Fructification of Ferns...	,,
Nerves of Teeth	T. C. White.

December 22nd, 1871.—*Chairman*, Henry Lee, Esq., F.L.S., &c., Vice-President.

The following donations to the Club were announced :—

"The Monthly Microscopical Journal"	from the Publisher.
"Science Gossip"	the Publisher.
"Proceedings of the Royal Society"	the Society.
"Proceedings of the Literary and Philosophical Society of Manchester"	the Society.
"The American Naturalist"	in Exchange.

The thanks of the Club were unanimously voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Henry Lea, Mr. Daniel Ward, Mr. John Webber.

Mr. James Smith read a paper "On Cell Mounting," for which the thanks of the Club were returned.

The Chairman expressed his great satisfaction at the kind of paper read by Mr. Smith, and hoped that similar communications would be made more frequently than had lately been the case, for it should be borne in mind one of the chief objects of the Club was to encourage intercourse between those who were seeking information on such subjects; he felt he could not too strongly impress this upon the members. He fully appreciated the value of many of the papers which were read at the meetings, but notwithstanding this he was very desirous of seeing the meetings assume more of a conversational character, and that the feeling should be encouraged that any member needing information could come there without being afraid to ask a question.

Mr. McIntire inquired how Mr. Smith got the lead so perfectly smooth as it appeared in the specimens laid on the table?

Mr. Smith replied that if the sheet lead was laid upon a plate of glass and then rubbed over with an ivory paper knife, it would become as perfectly smooth

as could be required. When the cells were cut out, by placing them between two ordinary glass slides, and applying a slight pressure, they could be made as flat as possibly could be. He might also add, that although those which he had described were square, yet rings might easily be cut out by using two punches of different sizes.

Dr. Matthews suggested that another method of flattening would be by rolling the lead out upon a sheet of stout plate glass with a piece of glass barometer tube, and he thought that by cross rolling the lead would be flattened better than by simply rubbing it with a ruler.

The Chairman observed that Dr. Bowerbank had used nothing else than common tea lead for his smaller cells for many years past, and for larger cells he used common plumbers' sheet lead. All his large collection of sponges were mounted in this way. It did not, perhaps, have a very neat appearance, but certainly answered the purpose very well. He believed that the doctor flattens out the lead on a board.

Mr. Smith said the cells were very easily made, so that two or three dozens of them could be made in the course of half an hour.

Mr. Richards said that some time ago he had to mount some wood sections, and procured for the purpose some rather light tin foil, which he cut out into cells with two punches, putting a piece of tube between them to keep them the right distance apart. A solution of glue and treacle was used for fixing them; this was laid on and allowed to dry first, and was found very useful in sticking on the thin glass covers, as it only needed a slight moisture to render it adhesive, whereas any liquid would have run under it and into so shallow a cell as the one he had described.

The Chairman remarked that this was carried out in a more perfect manner in the cells introduced by Mr. Suffolk.

Dr. Matthews said he found a difficulty in using these cells, because he could not fix them on with marine glue, which required a temperature so high to melt it that the tin cells were in danger of melting also.

The Chairman remarked that he used nothing else himself but marine glue to fix the tin cells to the slides, and it answered admirably.

Mr. Smith said his method was to fix them by running a ring of gold size upon the slide.

The Secretary said he was very much obliged to Mr. Smith for bringing this subject before the meeting. For many years he had been in the habit of using cells made of a thin kind of lead known as "pattern lead," which was used by dentists for taking patterns for their gold plates. It would be found to answer the purpose very well, and had none of the objectionable qualities mentioned by Dr. Matthews, since the slide might be made almost red-hot without melting the cells, and the cells were very easily stuck on with marine glue. For shallow cells a simple ring of gold size, and gum dammar put on thickly and allowed to get hard, answered the purpose very well, and if Bastian's cement were used instead, the cell could easily be built up higher by adding layers upon those which had become dry. Another way was to use the zinc cells, which would stand any amount of heat; acid, however, would affect these, but vulcanite cells would resist acids. In making cells for mounting in fluid, it would be found of great advantage to set up some standard size, and keep to it, as this would enable the worker in a short time to estimate correctly the exact amount of fluid required for filling—a matter of very much importance.

Mr. Leifchild asked if Mr. White considered the vulcanite cells to be the best?

Mr. White said he thought they would be, where acids were used.

Mr. McIntire said that he had used the vulcanite cells, and found they had a tendency to chip off the slides after a time.

Mr. White thought this would very likely be the case, because if the slide were made too hot the vulcanite would melt; but if not hot enough, the cement would not become sufficiently melted to make them adhere.

The Chairman proposed a vote of thanks to Mr. Smith for his communication, which was carried unanimously.

The Secretary, in announcing the meetings for the ensuing month, congratulated the members upon the fact that the Club would enter upon the new year 1872 with 560 members upon its list.

The Chairman said he should be very glad to see a greater number of objects exhibited at the close of the meetings; they added very much to the life of the conversaziones into which the meetings were then resolved, and he hoped that members would not forget this.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Proboscis of Vanessa	by Mr. Bevington.
Vaginecola (species)	Mr. Bucknall.
Poison Fang of Viper	Mr. Tafe.
Circulation in *Anacharis Alsinastrum*	Mr. Geo. Williams.

Attendance—Members, 62; visitors, 3.

January 12th, 1872.—Conversational Meeting.

The objects exhibited were:—

Isthmia enervis	W. H. Golding.
Ear of Frog injected (polarised)	M. de Guimaraens
Calcareous plates round mouth of Echinus ...	J. G. Waller.
Skin, &c., of Star Fish...	,,
Skin of Ray, all palarized	,,
Catenicella (Australian Zoophyte)	S. J. McIntire.
Section of Crystalline Lens from eye of Haddock, ½-in. obj.	J A. Smith.
Vorticella microstoma	Geo. Williams.
Rotifer vulgaris	,,
Section of Tooth of Cape Ant-Eater...	Mr Gibson.
Parasite of Water Rat	Dr. Ramsbotham.
Cells of Caddis worm (*Phryganea*)	,,
Young of *Asterina gibbosa*	T. C. White.

Attendance—37 members, 2 visitors.

January 26th, 1872.—*Chairman*, Dr. Lionel S. Beale, F.R.S., &c., President.

The following donations to the Club were announced:—

"Land and Water" (weekly)	from the Edi or.
"The Monthly Microscopical Journal"	the Publisher.
"Science Gossip"	the Publisher.
"The Popular Science Review"	the Publisher.

"Proceedings of the Manchester Literary and Philosophical Society"	the Society.
"The American Naturalist"	in exchange,
"Journal of the London Institution"	the Librarian.
A 2in. Objective	Mr. Rowlett.

The thanks of the Club were unanimously voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. Edwin Denyer, Mr. Robert Hudson, F.R.S., Dr. J. Hamilton McKechnie, Mr. Edwin Tulley Newton, and Mr. Frederick George Hilton Price.

The President regretted to have to announce that there was no paper to be read that evening, but several gentlemen had communications to make to the Club.

Mr. James Smith made some observations explanatory of improvements to a new substage for the microscope, which he recently introduced to the notice of the members. The stage, as now constructed, was exhibited and described, and a vote of thanks was passed to Mr. Smith for his communication.

Dr. Matthews said that most of the members of the Club would, no doubt, recollect that he had produced a self-centring turn-table, about a year ago (May 27th, 1870), and exhibited it at one of the meetings. It was then pronounced to be excellent, and it remained excellent for new slides, but in most cabinets there occurred a necessity for revarnishing old slides, and cells on these were not always found to be central. In such cases this turn-table would only correctly centre them, and thereby show their eccentricity, and its accuracy thus became a defect, although it was a defect consequent upon its perfection. He had, however, now devised a remedy for this by dividing the top of the table into two portions, so arranged, that by sliding the upper part upon the surface of the lower, any required degree of eccentricity could be attained. This was accomplished very easily and simply, and he thought that the arrangement rendered the turn-table as perfect as could be desired; certainly he did not himself see what more could be done to it. One of the improved turn-tables was then exhibited to the meeting, and its utility shown by centring a slide which had been eccentrically mounted for the purpose.

The President said that Dr. Matthews had exhibited a very practical arrangement, and one which certainly rendered his ingenious turn-table as perfect as could possibly be.

Mr. T. Curties said that Mr. Aylward, of Manchester, had sent two things to the meeting that evening for exhibition. One was a triple nose-piece of his own construction, and which appeared to be more successfully made than many of those in common use; it centred the objectives very easily, and worked smoothly and well. The other was a contrivance devised for the purpose of getting objects out of reach. It consisted of a pair of forceps and a cutter, arranged so as to be fixed at the end of a stick, and having two strings attached, one of which, on being pulled, closed the forceps, and thus held the object fast, whilst the other worked the cutter and severed it.

The President proposed votes of thanks to those gentlemen who had favoured the meeting with their communications, and also called attention to the 2in. objective which had that evening been presented to the Club by Mr Rowlett, for use with the tank microscope which belonged to them. This power was of excellent quality, and was one of Mr. Rowlett's own manufacture.

The Secretary announced that it had been decided to hold the annual soirée of the club on the 15th of March, and it was further intimated that the Committee had decided that members who had not paid their subscriptions ought

not in fairness to have soirée tickets sent to them, a decision which was greeted with applause and unmistakable signs of satisfaction by the members present.

Seven gentlemen having been proposed for membership, the proceedings terminated with a conversazione, at which the following objects were exhibited :—

Triple nose-piece and cutting forceps, for collecting sticks	by Mr. Aylward, of Manchester.
Parasite of Elephant...	Mr. T. Curties.
Legs of Curculio	Mr. Duck.
Surface markings on Triceratium and *Isthmia enervis*...	Mr. Green.
Anystis Cursoria	Mr. de Guimaraens.
Melicerta ringens (alive) ... ... *Membranipora pilosa*	Mr. Hainworth.
Fibro-cellular tissue of *Catasetum tridentatum*	Mr. Jackson.
Erecting arrangement adapted for dissection, &c., with Binocular Microscope	Mr. Oxley.
Pleurosigma formosum	Mr. Richards.
Cyclosis in Anacharis	Mr. J. Russell.
Æcidium Euphorbiæ	Mr. Sigsworth.
Wing of Moth	Mr. Jas. Smith.
Injected toe of Mouse	Mr. A. Topping.
Injected ear of White Mouse	Mr. A. Waller.

Attendance—Members, 96 ; visitors, 10.

FEBRUARY 9TH, 1872.—CONVERSATIONAL MEETING.

The following objects were exhibited :—

Sponge, *Geodia Barettii*	H. F. Hailes.
Tingis foliacea	Mr. Allbon.
Markings of Diatoms with high powers—opaque	Mr. Green.
Fly's Tongue	Mr. Richards.
Transverse section of small intestine of Cat ...	Mr. Topping.
Cinnabar Crystals in Chalcedony	Mr. Gibson.
Hydra, Volvox, Stentors, &c.	Mr. Martinelli.
Astromma Aristotelis	A. Waller.
Cigromyza flaveola	Geo. Williams.

FEBRUARY 23rd, 1872.—*Chairman*, DR. R. BRAITHWAITE, F.L.S., &c., Vice-President.

The following donations to the Club were announced :—

"Land and Water" (weekly)...	...from the Editor.
"The Monthly Microscopical Journal"	the Publisher.
"Science Gossip"	the Publisher.
"The American Naturalist"	in Exchange.
"The Proceedings of the Literary and Philosophical Society of Manchester"	the Society.
"The Invisible World," by Dr. Mantell	Mr. C. S. Bentley.

The thanks of the Club were voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. A. Atkins, M.R.C.S., Mr. A. Atkins, junr., L.R.C.P., the Rev. Thos. Henry Brown, Mr. Alexander Colvin, Mr. Theodore Charles Izod, Dr. W. E. Grindley Pearce, Mr. C. R. Stevens.

The Secretary read to the meeting the second portion of a paper by Mr. Furlongue, "On the minute Anatomy of the Flea" *(Pulex Irritans)*, illustrated by diagrams.

The Chairman proposed a very cordial vote of thanks to Mr. Furlonge for his very interesting paper. To have all the details of such a subject laid before them, so as to be read at any time, would be of great service. He hoped that other members of the Club would be induced to follow Mr. Furlonge's example, and carefully follow up some one subject in the same manner. There were many other insects about which it would be very desirable to know more. The bug, for example, would furnish a subject, and there were also many other fleas beside the one which formed the subject of the paper which had been read, such as the flea of the dog, cat, mole, fowl, and others, each of which had some peculiarities to distinguish it.

A vote of thanks to Mr. Furlonge was then put to the meeting and carried unanimously.

Mr. S. J. McIntire said that, being unprepared for it, he was rather surprised that his remarks had been quoted by Mr. Furlonge in his paper, and that he should now be called upon to repeat them. Mr. Furlonge merely asked him some time ago if he had ever witnessed the copula of fleas, and he replied that he had. At the time he was studying these insects he happened to have caught one—a female—and put it into a test tube. Soon afterwards he caught another, and put it into the tube also ; it proved to be a male flea, and they at once began copulating. The curious part of it was that the female got on the top of the male, and the male organ was turned round quite over his back to reach the female. With regard to other kinds of fleas, those of the mouse were very interesting ; they were very pretty little things, and were apparently blind. The largest flea in the world was that obtained from the Australian ant-eater. It was as large as a small-sized pea.

The Chairman said that the observation made by Mr. J. McIntire accounted for the enormous development of the penis in the male flea.

The Secretary said that he happened the other day to get out the gizzard of the flea, but he could not make out the corrugated bands referred to in Mr. Furlonge's paper. He saw, however, a number of *bristles*, which appeared to him to take the place of the teeth found in the gizzard of the cockroach and cricket.

Mr. Topping confirmed the observation of Mr. White, and said that if the gizzard were opened and laid out the bristles would be readily seen ; if the gizzard of the dog-flea were examined it would be found different.

Mr. Oxley said that he had also observed the bristles alluded to by Mr. White.

Mr. Matthews introduced to the meeting a portable case and stand for a microscope lamp. He thought that persons were generally disirous of diminishing the weight of their accessory apparatus, as well as that of their instruments, and endeavoured to dispense with as many pieces as possible. He had in this instance attempted to meet this desire by dispensing with the ring, stand, and upright supporting rod, and making the case itself into a support and stand. This was accomplished by making grooves in the sides of the interior of the case, into which a wood shelf supporting the lamp was made to slide. This simple contrivance he had found to answer perfectly; the grooves were ½in. apart, and the lamp was quite steady even when the top groove was used. When the shelf and lamp were placed at the bottom of the case, the door could be shut, and the case conveniently carried about by means of a brass bail handle. The lamp was one of Mr. How's, with an earthen chimney, and the only inconvenience he had found arose from the great heat radiated from the chimney. He had, there-

fore, sought to obviate this by clothing the chimney with felt, and found it to answer the purpose very well. The box itself absorbed some of the heat, and the felt so far absorbed the rest that no inconvenience could now be said to arise from that source. The felt was sewn on round the top of the chimney, and fixed at the bottom by a piece of coiled watch-spring, the chimney being too hard to pierce through. The case and lamp could be supplied complete at a cost of 17s. 6d. or 18s.

The Chairman thought these contrivances very ingenious, and expressed the obligation of the Club to Dr. Matthews for bringing them before their notice.

Mr. Green intimated that he had taken the opportunity of bringing the lime light to the last gossip meeting, and the unanimous opinion of those members who saw the diatoms illuminated by it was in accordance with the description given in his paper. The hemispherical dots were particularly high in Hippocampus; in Formosum there was evidently a flattened surface, and this was still more so in Angulatum. It should be remembered that there was no covering glass over the specimens, neither were they seen through any other medium, and when shown thus in their natural condition by transmitted light as opaque objects, the "file marks" were seen to be unquestionable depressions. In this controversy, as in some others, it might be said that the opinions of both sides seemed to be true. In order that those members who were not present on the occasion when he exhibited the diatoms before might have an opportunity of seeing and judging for themselves, he had again brought the lime light with him, and should be happy to exhibit the objects at the close of the meeting.

The proceedings then terminated with a conversazione, at which the following objects were exhibited :—

Wing of *Morpho Menelaus*	by Mr. Golding.
Unmounted Diatoms, illuminated as opaque objects, by the lime light	Mr. Green.
Injected Skin of Frog...	Mr. de Guimaraens.
Fungus Leaf of Coleus	Mr. Jackson.
Confervæ	Mr. Martinelli.
Tongue of Blow-Fly	Mr Richards.
Antennæ of Lace Wing Fly	Mr. Sigsworth.
Transverse Section of Ox-tongue	Mr. J. A. Smith.
Heliopelta metii	Mr. Geo. Williams.

Attendance—Members, 89; visitors, 11.

R. T. Lewis.

March 8th, 1872.—Conversational Meeting.

The following objects were exhibited :—

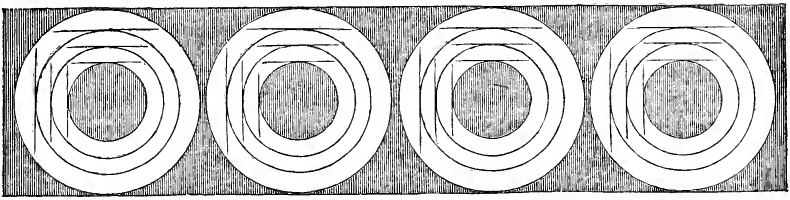
Red Earth Mite	Mr. Fitch.
Wing of *Pterophorus pentadactylus*...	Mr. Ward.
Culex annulata, Large Winged Gnat	Geo. Williams.
Various Lichens	W. H. Golding.
Parasite of Ox	H. E. Freeman.
Australian Polyzoa, &c.	E. P. Pett.
Echinus Spines...	,,
Thyamis femoralis, Grass Flea	F. W. Andrew.
Various Echinus Spines in Section	Mr. Gibson.
Anthers of Mallow	Mr. Sigsworth.

Attendance—63 members, 6 visitors.

On Cutting Cells.

By James Smith.

(Read 22nd December, 1871.)



In the above diagram I have endeavoured to indicate a very simple, but I think, at the same time, very accurate way of cutting out cells for mounting Microscopic objects. The material I have employed is the lead used for lining tea chests; the advantages of this were pointed out to me some time ago by Dr. Bowerbank, who has, I believe, used it for some time as a material for making cells. It is very readily obtainable from any grocer; can be had of several degrees of thickness, and, from its extreme pliability, can be very readily flattened out or moulded into any required shape, and I think that, without disparaging any other substances employed in cell making, that this sheet lead will be found useful for many kinds of mounting, and the readiness with which it can be obtained makes it all the more desirable. A piece of lead having been obtained, and properly smoothed out; slips of—say 1 inch in breadth, and any convenient length may be cut off, and being marked with small lines (or dots) as above, as a guide for placing the punches in cutting, two or more cells may be cut out of each other with great accuracy and very little trouble. In the above diagram four punches are supposed to be used, namely—a 1 inch, $\frac{3}{4}$ inch, $\frac{1}{2}$ inch, and $\frac{1}{4}$ inch punch; and, as will be seen from the diagram, twelve cells of three different sizes are thus cut from the small strip of lead represented. It is scarcely necessary to say that this method of cutting will do equally well for other materials used in cell making.

On the Measurement of the Working Focal Length of Object-Glasses, and their Magnifying Power.

By G. West Royston-Pigott, M.A., M.D., Cantab , M.R.C.P., M.R.I., Fellow of the Cambridge Philosophical, the Royal Astronomical and Microscopical Societies, late Fellow of St. Peter's College, Cambridge.

Though strange, it is nevertheless true, that two observers, with the same eyepiece and objective, do not always see an object magnified to the same amplitude. A change of focus may be necessary. A short-sighted person sees the *virtual image* of the magnified object at a distance of perhaps six inches ; the long-sighted adjusts it perhaps at twelve or even eighteen inches ; the distinct plane of vision, called the field of view, is variably placed according to the focal length of the eye of the observer, and therefore at distances of considerable variety. Under these circumstances, if two observers, the one very short, and the other very long-sighted, both agree to observe together, their powers of vision proportionably vary. It is necessary, then, to fix a standard for estimation. Most persons can see distinctly at *ten* inches distance. In this case the power of any lens at this distance is found by dividing ten by the focal length f or

$$\text{Magnifying power} = 10 \div \text{focal length } f$$

$$\text{or} = \frac{10}{f} \text{ or } 10 \div f.$$

To persons unread in optical principles, there appears some little difficulty in understanding the variable foci of a lens, and I may, perhaps, be excused for introducing the following illustration, known I believe to very few working opticians :—If we take a lens (say 3 inches focus), and form the image of a candle (or much better, the image of a small perforation in a brass plate placed before it) upon a sheet of white paper, it is well known that as you move the candle from the lens you must move up the paper towards it, in order to obtain a clear image. Now, the special point which I wish to bring before the notice of the members of the Quekett Club is

this, that exactly at the position where the image is formed clearly at the same distance from the paper as the candle is, the distance between the candle and image is the least possible or a *minimum*. A most useful result is now obtained; in every case this *minimum* distance is exactly *four* times the focal length of the lens. In the case of a three-inch lens this *minimum image distance* will be found to be exactly 12 inches.

We will now suppose that instead of the three-inch lens a two-inch objective is used in precisely the same way. The *minimum* image distance between a candle and its image will be found much less than 8 inches, so that the real focal length* is $1\frac{14}{36}$ or rather less than one inch and a half.

There are two or three preliminary points which may not be uninteresting. To find the focal length of a plano-convex lens, turn the *flat side* to the sun, and measure the exact distance from the sharpest image on a card to the *convex surface*.

If the lens be equiconvex, half the thickness must be added.

If the lens be used as a convexo-plane, and the plane side is towards the image, when the aberration is reduced, *two-thirds* of the thickness must be added.

The minimum image-distance avoids these inconveniences of measurement altogether.

In every case the true focal length will be more accurately determined by using only a small central aperture applied to the lens in question.

I have designed an instrument of considerable accuracy for measuring the focal length of ordinary lenses, consisting of a perforated metal plate, and a white screen or piece of ground glass, with a carrier for the object-glass or lens. By means of a long screw tapped with similar right-handed and left-handed *dies*, the perforated plate and lamp and the screen are simultaneously made to approach or recede from the lens, which is thus kept always exactly equidistant from the plate and from the screen. The lens to be measured being fixed, the screw is turned, until an exact image is formed upon the screen, of the perforations; one-fourth of the distance between them is exactly the focal length required. I term this instrument a *Focimeter*.

But in the case of very minute lenses, considerable difficulty is

* Focal point of a lens is generally known to be the focus of parallel rays.

experienced in finding their exact focal length by measurement of their curves. In this case, the focal length can be obtained most readily by the following artifice. If the magnifying power be great, a stage micrometer is to be placed exactly at ten inches distance from the ground glass screen. If a microscope be used, by taking out the field and eye-glasses of the eye-pieces, an ordinary circular 1-100th micrometer may be inserted; then replacing the eye-lens only, the image of the stage micrometer must be accurately observed, and the magnitude of a 1-100th nicely determined in the divisions of the eye-piece micrometer. Suppose this to be (m), the actual focal length of the lens in question will be found *for small lenses* as follows:—

Divide ten by this number (m), increased by two.* Larger lenses will require a correction to be hereafter explained.

Example.—A small lens is found to magnify a hundredth of an inch upon the stage to measure 35 hundredths at 10 inches distance from the stage, within the field of an eye-piece, deprived of its field lens. Find the focal length; also for a plano convex find the curvature of the tool to grind the lens.

$$N = 35. \quad f = 10 \div (M + 2) = 10 \div 37$$
$$= 0''{\cdot}27027 \text{ nearly.}$$

In a plano convex lens radius of curvature for flint—

$$= \tfrac{1}{2} \text{ focal length} = 0''{\cdot}13513 \text{ inches.}\dagger$$

Example 2.—A compound lens forming an object glass of great power enlarges the thousandth of an inch to 158 divisions in 1000ths, as before at 10 inches. Find the approximate focal length. Here

$$f = 10 \div (158 + 2) = 10 \div 160 = \tfrac{1}{61} \ddagger$$

* In a paper contributed to the "Philosophical Transactions," March, 1870, I showed that this number (m), or the number of times the image is magnified by the lens, is equal to $\frac{d}{f} - 2$, for small lenses, or $m = \frac{d}{f} - 2$; whence $f = \frac{d}{m+2}$

† If perfect accuracy is required the number m (35) should be increased by the reciprocal of m, namely, $\frac{1}{35}$; and the distance to be then divided not by 35 + 2, but by $35 + 2 + \frac{1}{35}$, or 37·028571, which gives

0''·270062, instead of 0''·27027 inches.

‡ Most persons will find a difficulty in reading 158 thousandths, or 15·8 hundredths, on the eye micrometer; indeed, they would more nearly read 160.

The decimal change for the omission of the reciprocal $\frac{1}{158}$ in the divisor, which ought accurately to be $158 + 2 + \frac{1}{158}$, is very slight. Performing the operation, $158 + 2 + \frac{1}{158}$, for a new divisor = 160·0063291.

$$f = 10 \div (160{\cdot}0063291) = 0{\cdot}062497 \text{ nearly}$$
$$\text{Now } \tfrac{1}{16} \qquad = 0{\cdot}062500$$

Difference = ·000003

Which is less than the 10,000th of an each. So that when Powell and Lealands $\frac{1}{16}$ magnifies 1600 times with a C eye-piece of one inch focal length, it is accurately $\frac{1}{16}$th focal length within an almost inappreciable quantity.

From this it appears that an exact sixteenth should produce an image precisely 158 times as large when the object is exactly ten inches from the field of the eye-lens at the stop of the eye-piece.

For practical purposes, therefore, an eye-lens magnifying ten times would enlarge the object in this case 1,580 times. Now a C eye-piece of Powell and Lealand is just equivalent to an one-inch lens; therefore, when these makers announce their sixteenth to magnify 1,600 times with a C eye-piece, this objective is nearly the $\frac{1}{16}$ of an inch *focal length* within a small decimal.

The magnifying power employed at any moment is often so great a desideratum, and yet so unattainable (when one is closely engaged in some delicate investigation, and using a variety of objectives), without great loss of time, that the following observations upon a simple method exhibited at the meeting of the Fellows of the Royal Microscopical Society last month, may, it is hoped, prove acceptable. Having met with many persons and some opticians who experienced a difficulty in understanding the reason of the thing, I trust that the preceding remarks will clear the difficulty away.

If we settle it as an axiom for very high powers, such as the $\frac{1}{8}$th and $\frac{1}{16}$th, that at *ten* inches distance of the stop of an eye-piece, without the field-glass, the enlargement of thousandths on the stage will give the focal length simply by dividing ten by the amplification increased by two, then it is evident that by using a single lens of one-inch focal length magnifying ten times, if we count how many hundredths of an inch in the stop correspond to a hundredth on the stage micrometer, ten times that amount with an inch or C eye-piece is the magnifying power. Now replace the field-lens (usually of 3-inch focus) for an eye-piece of 2-inch focal length, having an eye-lens of one inch, the magnifying power will be reduced considerably in the proportion shewn by the new reading. Whatever object glass is now used, and whatever length of tube happens to be in use, so long as the eye-lens is 1-inch focal length, *ten times* the apparent amplification of the stage micrometer will give the power under employment.

I keep an eye-piece (two-inch) with *one*-inch eye lens, armed with a glass micrometer, ready for use. Every microscopist should demand that the optician mark the focal length of each of his eye-pieces. Powell and Lealand's C eye-piece is exactly one-inch focal length; and at the usual distance of *ten* inches the power of any object glass with it is at once found by multiplying the re-

ciprocal of the focal length (eight is the reciprocal of $\frac{1}{8}$) by one hundred.

The standard rule by which nominal "inches," "quarters," "eighths," "sixteenths," and "twentieths" are constructed is therefore most properly taken, so that with a C eye-piece of one inch focal length and the stop of the eye-piece being exactly ten inches from the stage, their respective magnifying powers shall be:—

(Objectives) ...	Inch	Quarter	Eighth	Sixteenth	Twentieth
(Powers)	100	400	800	1,600	2,000

I have found Nobert's lines to form very beautiful stage micrometers; but as they are fractions of the Paris line, observations with them require laborious reduction to the English standard. But I wish to acknowledge here the kindness of Mr. Baker, the optician, in placing at my disposal Jackson's own beautifully ruled micrometer lines, 2,000 to the inch. With the aid of this, and a micrometer in the stop of the eye-piece, I found the *power* of Powell and Lealand's new $\frac{1}{8}$, with a one inch Kellner of Browning's make and searcher (with a fine definition), to be 5,250 diameters.

Without searcher and one-inch eye-piece:—

Andrew Ross . . .	1851 .	"quarter"	. power, 540	nearly $= \frac{1}{5}$th.
Wray	1870 .	one-fifth	. power, 540*	

Resumé.

I.—*The focal length of a lens is one-fourth the least distance between image and object at which it can be distinctly formed.*

II.—If a distance of ten inches between object and image be taken (to simplify the calculation), and the amplification measured for a division, then in the case of small lenses the focal length is found by dividing ten by the divisor increased by two.

III.—The magnifying power of an object glass for any length of tube can be ascertained by using an eye-lens of one-inch focal length, with or without a field lens, by measuring the amplification of a stage micrometer upon another placed in the stop of the eye-piece, and then multiplying it by ten.

IV.—Different eye-pieces being compared by the Camera Lucida, or marked in focal length by the maker, all other powers are immediately ascertained by the simple rule of proportion.†

* The actual focal length $= 10 \div (54 + 2 + \frac{1}{54}) = 10 \div (56 \cdot 0185)$; or a power of 540 represents a focal length about 2-100ths of an inch less than a true $\frac{1}{5}$.

† A half-inch eye-piece will of course be twice the power of the inch, and so forth.

Upon a Phenomenon of Monocular Vision in Connection with the Delineation of Microscopic Objects.

By W. H. Furlonge.

(Read April 26th, 1872.)

There are few departments of manipulation of greater importance to the working microscopist than the means of delineating, with accuracy and rapidity, the objects which, from time to time, are brought under his notice. Facility in drawing from the object as seen in the microscope, by the unaided eye, is a comparatively rare accomplishment, and even where there exists a natural artistic aptitude, it is only by long practice, and after many painful failures, that such facility can be attained. Hence the value of what may be termed *mechanical* aids in the delineation of objects, such as the Camera Lucida, and other forms of reflecting prisms, the steel disc, and the neutral tint reflector.

It is not my purpose to enter into the respective merits of these and other methods of microscopic drawing, but to bring under the notice of the Club a phenomenon of vision connected with the employment of the last-named instrument—the neutral tint reflector—which appears to me very remarkable, and deserving of further investigation, not solely because of its interest in connection with mental, nervous, or brain impressions, but also on account of its bearing upon practical working facility in microscopic drawing.

We are all familiar with the neutral tint reflector, and with the optical principles involved in its construction. As usually made, this instrument is furnished with several reflecting glasses of different depths of colour, to adapt it for use with an illumination of greater or less intensity. Even with such appliances, however, we are most of us aware that it is a matter of some difficulty to obtain the best balance between the illumination of the object in the microscope, and that of the paper upon which the drawing is to

be made, and that to produce the best effect it is necessary to screen the paper from too bright a light.

Some months since, in attempting to accomplish this adjustment, I chanced to hit upon a singularly happy illumination of the paper, by means of which I was enabled to trace the object under observation with more than ordinary facility. On removing my eye from the instrument, however, I was greatly surprised to find that in shading my drawing paper to produce the best effect, I had actually interposed the margin of the screen between the observing eye and the drawing-paper. I had thus completely cut off all possibility of vision of the reflected image through the neutral tint glass with the observing eye; yet the apparent projection of the image upon the paper was seen with increased distinctness. Repeated experiments only served to confirm the reality of this singular phenomenon of vision, and to prove that the best mode of using the reflector as a drawing instrument was to employ a piece of glass which had been made *perfectly opaque* by the application to its under surface of a thick coating of black varnish, such as asphaltum, instead of the transparent neutral tinted glass.

Now let us consider the *rationale* of this curious fact. It will be at once perceived that we must entirely modify the views hitherto held as to the principles upon which we are enabled to perceive the image reflected by the neutral tint—and, in fact, by every other form of reflector—upon the paper on which we draw. These principles I take to be, that the pencils of light forming the image in the microscope are reflected into the observing eye, which, looking *through* the transparent reflecting glass, sees the image apparently projected upon the drawing-paper beneath—the office of the non-observing eye being to direct the point of the pencil while the object is being traced. But the experiment I have described proves that the observing eye does *not* see through the reflecting glass at all, and that in reality it is the non-observing eye—that is the eye which is not looking into the instrument—that perceives the image, and is called upon simultaneously to direct the pencil. This at once explains the difficulty we all feel, more or less, in keeping the point of the pencil constantly in view, and why it is that in tracing an object we are so continually and provokingly losing sight either of the pencil or of the object.

I do not propose here to enter upon the somewhat abstruse enquiry, how the mental impression conveyed to the brain by one

eye is seen by the other apparently projected upon the drawing-paper on which it is looking. In fact, the question appears to me to belong more to psychology, or at all events to the most recondite physiological considerations of reflex nervous impressions, than to practical microscopy. It is very probable, however, that some of our members, and notably our President, are capable of throwing light upon the cause of this remarkable phenomenon, which it would be very desirable to obtain. My present object is simply to bring the fact itself before the Club, to point out its practical bearing upon our every-day work, and to suggest to some of our ingenious mechanical members, who may have the time to devote to the investigation, that it may be very possible to improve the brilliancy of the image projected on the paper, and consequently to increase the facility in tracing it, by the substitution of a very truly and highly-polished plane *metallic* speculum, for the opaque glass reflector I have described.

The late Mons. A. de Brebisson.

One of the Foreign corresponding members of the Club, Mons. Alphonse de Brebisson, of Falaise, Normandy, died on the 26th April last, at the advanced age of 74 years. His large and valuable collection of some thousands of slides of Diatomaceæ is to be disposed of by his son, M. René de Brebisson.

Observations on the Fresh-water Sponges.

By J. G. Waller.

(Read April 26th, 1872.)

On the Fresh-water Sponges more has been written, than on any other genus of this order of the Protozoa. This may be accounted for in the ease with which they are found, and in consequence their examination involves but little difficulty. It is not, therefore, my intention to aim at anything like completeness, but strictly to confine myself to that which the title of my paper suggests, viz., "Observations." This relieves me from the dangerous temptation to theorise, and thus I believe I shall do my duty best to myself and to you. I shall divide my task into two parts. In the first I shall give a general glance at the organisms under consideration, then a series of observations carried on with the growing sponge during three months, in which time I made drawings and memoranda daily, illustrating every change which took place.

The two Fresh-water Sponges, known in England, are distinguished as "Spongilla lacustris," and "Spongilla fluviatilis," literally the Lake and the River Sponge. These terms were given by Dr. Johnston, and are now generally accepted. Though they are thus distinguished, they may often be found growing in the same locality, under the same conditions, and within a few feet of each other.

The two are strikingly dissimilar, and yet their characteristics have been often confounded. *S. lacustris* grows in long, lobular, branching forms; *S. fluviatilis* in large masses, without symmetry. Yet it has been asserted, that the latter is also found with lobular projections, and Dr. Bowerbank suggests that this may be due to it having originally been parasitic on some Alga. I have myself seen several examples of this form, but arrive at quite another conclusion. At least, in those instances which have come under my observation, this was certainly not the cause, but a confervoid

growth, overlaying and oppressing the sponge, constrained its development in the usual way, and the lobular growth was in such places as were free from this parasitic obstruction. As soon, however, as the sponge escapes this its tendency to spread laterally is manifested, and the terminations of the lobes widen. I believe this is a weakly condition of the sponge, only seen in young examples, and not under healthier circumstances.

The external character, then, of the two is entirely dissimilar when mature and fully developed. Colour is a very variable character, dependant so much upon light, but, in general, *S. lacustris* is of a dark green, whilst that of *S. fluviatilis* varies from a dull yellow to an emerald tint. More intimate examination makes the distinction between them still wider. The membranes of *S. lacustris* are covered with minute spiniferous spicula, whilst those of the other have none. The structure of the skeletons are similar, but coarser in the former than in the latter. Their spicula have but slight differences; and whilst on this part of my subject, I must call attention to what is somewhat remarkable—that in both these sponges a form of spiculum has entirely been overlooked by those eminent observers who have done so much to instruct us on this interesting group of organisms.

Dr. Bowerbank, in his work on the British Spongiadæ, which must now be regarded as the text-book on Sponges, gives only one form of spicula as belonging to the skeleton of either of the British Spongilla. That of *S. fluviatilis* he calls "Acerate," that of *S. lacustris* "Subfusiform Acerate." As regards the first, if you take a mature example of the sponge and make a vertical section, mount it in balsam and examine it under the microscope, you will find that nearly the whole of the spicula are *spiniferous*, the plain "Acerate" form being very few in number. But now make a horizontal section, and examine it in a similar manner, and then the spiniferous form is found to be few in number, the greater part being that which Dr. Bowerbank has described. This at once shows us the true position each occupies in the skeleton, and that there are two forms is without doubt. The question now arises how this form could possibly be overlooked if it be constant. I am not sure if I have always seen it myself—and I have seen a slide sold as "Spicules of *S. fluviatilis*," in which it certainly did not appear; nevertheless, I am inclined to think it a constant characteristic in mature examples. In *S. lacustris* the spiniferous spicule does not

constitute more than 6 or 7 per cent. of its skeleton, and it is somewhat shorter than the others. The next point of dissimilarity between them is in the structure of the ovaria, so far as regards the spicula of the integument.

The bi-rotulate form of *S. fluviatilis* must be known to every microscopist, as it is so frequently figured in works on the Microscope. Those of *S. lacustris* are totally different, being similar in character, though smaller, to those of its membranes, but varying in their curvatures to such an extent that I have occasionally seen them taking that of a complete circle. The preparation of the ovaria showing the spicula is extremely easy. There is no necessity for any boiling in nitric acid, as recommended by Dr. Bowerbank, but a section of the sponge containing them needs only to be steeped in strong spirits of turpentine for a few days, and then mounted in balsam to show their structure completely, and it is the more interesting as they are seen *in situ*.

There is another characteristic of the latter sponge which observers have not failed to note, *i. e.*, the numerous abnormal forms of spiculum which are found in it. But, indeed, they are quite as numerous in *S. fluviatilis*, and they are so far worth our notice when they seem to play into shapes, which in other sponges are constant. But I will now pass from these somewhat dry details to matters of more interest.

In the early part of November, 1870, accompanied by a friend, I went into Hampton Lock, in search of the Fresh-water Sponges, and returned home laden with a rich gathering of, as I thought, both species. But it entirely consisted of *S. fluviatilis*, the lobular form of which deceived me, as I took it to be *S. lacustris*. On reaching home and submitting a portion to examination, I found it was pouring out a yelky substance of a dirty white colour, which proved to consist of myriads of ova. These had a tendency to aggregate together in masses upon the slide, perhaps by the law of attraction, but in some cases these masses immediately threw out a membranous projection like the pseudopodia of the Amæba, which they closely resembled; and I regret that I was not able just then, for want of leisure, to follow up any subsequent development. After setting aside some pieces of the sponge as specimens, a few fragments were left in the gathering bottle. This soon became exceedingly offensive and perfectly black with decomposition. In a few days, however, purification ensued in the usual manner; I

filled up the bottle with fresh water and set it aside out of the direct light, where it remained all the winter. About the middle of March, 1871, I examined it, and observed a green spot on a fragment of the old sponge left in the autumn. On applying a lens to the side, I was delighted to find it was a young sponge developing its membranes upon it. Considering the decomposition to which I have referred, I did not expect such a result.

But instead of giving an account of this, which was somewhat advanced in development, I will select another example, which I found as a minute white speck upon the side of the bottle, thereby rendering it easy of examination. It consisted entirely of a pellucid membrane, supported or strengthened by spicula which projected slightly from its surface, enclosing denser granular matter, in which the pores could easily be detected by an inch objective. The osculum was remarkably developed, but being situated on the other side of the sponge was not always visible; yet I had frequent opportunities of examining this curious organ. It was a transparent tube, generally somewhat larger at its distal extremity, often very long in proportion to the mass of sponge when fully extended, corrugated in structure and frequently having upon its surface a spiculum here and there without any order. One end of the sponge was attached to an ovarian capsule, divested of its outer integument and spicula. This served throughout my observations as a pointer, for, being a fixed object, it indicated the nature of the changes, both of position and of form, which took place from day to day. These are difficult to describe, but will be understood by aid of the accompanying figures, selected from the numerous drawings made.

Plate iii, Fig. 1 represents the sponge when first discovered, May 18. The following show the successive changes according to dates annexed :—Fig. 2, May 25; Fig. 3, May 31; Fig. 4, June 7; Fig. 5, June 10; Fig. 6, June 12; Fig. 7, June 15; Fig. 8, June 17. The last shows the condition just before it separated.

The nature of the development was a contraction, so that the flat membranous expansion was drawn by degrees into another shape, denser in character, and gradually taking a globular form. During this process some of the external spicula of its network were left upon the sides of the glass; and on the 7th day after my observations began a faint tinge of green was visible in the central portion. This colour increased daily with the progress of con-

traction, and the density of the organism; the projecting osculum was withdrawn, and in three weeks disappeared, leaving in its place a large opening or depression, which was very variable in size and appearance even on the same day. The sponge now assumed an ovate character, having a smooth surface, and no projecting spicula except at one end. From this it passed step by step into a globular form of a deep emerald green colour; its attachment to the capsule became smaller and smaller, until at length it broke away, and disappeared (Fig. 8).

Now this was exactly the course which every other specimen followed. All from an expanded membrane, covering granular matter, contracted into a globular shape, then separated from its attachment, and disappeared. The only difference being that colour was acquired in other instances, whilst it was still expanding and growing upon the old sponge, and some were larger than others. Every individual, if such an expression can be correctly applied, had one osculum projected from it, and on this interesting organ I will add a few more remarks. Dr. Bowerbank states that this pellucid tube "exists only during the course of the energetic excurrent action." As far as I have observed this was not exactly the case. By reference to Plate iii. you will perceive two conditions in the same example. In Fig. 1 the sponge is active, the dermal membrane is fully extended, supported, as it were, at the apices of the spicula, and reminding one of a tarpauline over a hay-rick. Here the osculum is firm and erect. In the passive state the membrane is contracted, the osculum hangs down in a flaccid state, and the sponge is evidently at rest (Fig. 2). I found if the sponge was disturbed it went directly into this condition, and I fancied, upon one or two occasions, a dull and heavy day produced the same effect. The corrugated structure of this organ shows that the power of contraction and expansion must exist to a great extent; but I never saw any absolute withdrawal of it, except under the conditions mentioned.

The phenomena, I have endeavoured to describe, seem to point to an act of gemmation with which we are familiarised in many of the lower orders of animal life, and which are well known to take place in, probably, every sponge; and yet these are great differences from our usual experience. Here it is clearly a young sponge which gradually assumes this appearance. It is well, therefore, to follow up the ensuing stage if possible, and happily this I am

enabled to do. Previous to the observation thus recorded, I had one with a gemmule (?) already perfected, which I discovered embedded within the network of a piece of old sponge. It had evidently passed through the stages I have mentioned, and had now found a resting place for further development. I placed it in a zoophyte trough, supplying it constantly with fresh water, and observed it to be enveloped in a transparent membrane, defended or strengthened by a few spicula. It was sub-globular in shape, and of a bright emerald green colour (Fig. 3). I watched it daily. New membrane was forming about it on the network of the old sponge, and upon this new spicula (Fig. 4). This latter process was interesting. First one was projected, another extended from its apex, then one transversely. Additions were then made to the first parallel to it (See Fig. 5), and so forth.

Meanwhile the gemmule (?) was gradually increasing in size, swelling out and becoming more ovate, and its granular character more distinctly visible through the expanding membrane; and having been nearly a fortnight under observation, began now to break up. The envelope burst, and its contents, consisting of minute masses of sarcode, which, when aggregated together, had an amæbiform appearance, issued slowly from it (Fig. 6). Some of them settled upon portions of the membrane of the sponge, or upon the spicular network, and began to develope upon it. But by far the greater quantity became effete, as, perhaps, the conditions of life were little favourable for any further progress.

During my observations I saw upon several occasions minute bodies, ovate in shape, and having filiform appendages, moving about on the edges of the protruding granular masses, with a singular twitching motion; but I could not bring a power of more than 60 diameters to bear upon them, and hesitate to express my belief in their being spermatazoids, which are asserted to have been seen by more than one observer, but which fact nevertheless remains in obscurity.

I have spoken of the phenomena described as of "gemmation," and the product as a gemmule, yielding in this to appearances rather than believing the terms to be correct. A gemmule has been described as "a vital mass separated from the parent, and capable of being ultimately developed into a single individual, possessing the same specific characters and capabilities as the present mass." But this clearly must be understood of those acts which

are familiar to us in many organisms in an adult and matured condition. Here it is evidently not of that character, but is a stage of growth belonging to the young sponge, which may fairly be presumed to have commenced from one or more ova. In the instance here given, we have the sponge actually developed upon the ovarian capsule, and in immediate proximity to the foramen, through which the ova pass out, and was clearly in the earliest stage of development. It appears to me that the phenomena rather show an analogy to the encysted state observed in so many of the lower organisms, and had a resemblance in its result to what I witnessed in Actinophrys Sol.* This question I leave for others to decide, and hope there may be amongst our friends those whose experience may help us to a conclusion.

Of the food of the Fresh-water Sponges we know but little, yet, if we may judge from the abundance of diatomaceæ frequently seen upon their tissues, they at least must form a part of it. The following is a list of those varieties I have found upon the membranes and other portions of *S. lacustris*.

Pleurosigma attenuata	Cymbella gastroides
Navicula cuspidata	,, cuspidata
Meloseira nummuloides	,, boekii
Pinnularia major	Surirella biseriata
Cocconeis transversalis	Amphora ovalis
Campylodiscus spiralis	,, membranacea
Cymatopleura solea	Encyonema prostratum, &c., &c.
,, elliptica	

I must, however, mention that the sides of Hampton Lock, whence my specimen was taken, are so rich in Diatomaceæ as to look as if covered with treacle; and it would, therefore, be rather a marvel if we did not find some upon the membranes and other parts of a sponge growing in that locality.

* See Article on the Conjugation of Actinophys Sol.

ANNUAL SOIRÉE.

March 15th, 1872.

The Annual Soirée was held, by permission of the Council, at University College, Gower Street. Two hundred and sixteen microscopes were exhibited by Members of the Club, of the Croydon Microscopical Club, the South London Microscopical Club, the Forest Hill Microscopical Club, and the Metropolitan Opticians.

EXHIBITIONS BY MEMBERS.

Ackland, T. G.,	File of Cricket, *Acheta domestica*.
Ackland, W.,	Cinchonidine under polarized light, by a new form of selenite stage.
Allbon, W.,	Tongue of Lamb.
,,	Intestine of Ourang Outang.
Andrew, A. R.	*Anguinaria spatulata*.
Andrew, F. W.,	Leaves of *Alyssum montanum*.
,,	Hypersthene, a mineral from North America.
Atkinson, J.,	Foot of Blow Fly.
Bentley, C. S.,	Section of Shell *(Haliotis)*.
Bevington, Thos.,	Tongue of the Bee.
Bevington, W. A.,	Tongue of Butterfly, *Vanessa urticæ*.
Bishop, W.,	A water wood-louse, *Oniscus aquatilis*.
Bonella, John,	Sori of several Exotic Ferns.
Braithwaite, R., M.D.,	Coralline with animals expanded.
,,	Structure of Flowers, *Asarum Europæum* and *Thuja orientalis*.
Burr, T. W., F.R.A.S.,	Table polariscope with selenite designs, and unannealed glass.
,,	Photograms of the Moon in the Microscope.
Burt, C. W.,	Young Spider.
Cocks, W. G.,	*Conochilus*.
,,	*Volvox globator*.
,,	*Melicerta ringens*.
,,	Achromatic Stereoscope, with views tinted by coloured reflectors.
Crisp, J. S.,	*Malva sylvestris* (4-inch),
,,	*Lavatera rubra* (ditto).
Crisp, —	Spine of Echinus.
Crook, T.,	*Melicerta ringens*.
Curties, T.,	*Anguinaria spatulata* on Sea Weed, with Diatoms *in situ*.

CUSHING, THOS.,	Collection of Natural Flowers.
DAINTREY, G.,	Selected Diatomaceæ.
,,	Section of Skin of Cat.
,,	Polycystina.
DEANE, —	*Vibrio tritici*, the cockles or purples of corn.
DOBSON, H. H.,	Section of Pearl.
DUCK, W. A.,	Tongue and Lancets of a Fly (*Tabanus*).
FITCH, F.,	*Volvox globator*.
,,	*Stephanoceros Eichhornii*.
,,	Ciliary action in Tadpole.
FRYER, G. H,	Spiders and Eggs hatching.
,,	*Hydra viridis*.
FURNEAUX, J. R.,	Scales of Fern.
GARDINER, G.,	*Coneatus Tamarici*.
,,	Section of Whalebone, polarized.
GARNHAM, J.,	Human Muscle injected.
GAY, F. W.,	Nudibranchiate Mollusc.
,,	*Embletonia Grayi*.
,,	*Lophopus crystallinus*.
GEORGE, E.,	Fructification of Mosses.
,,	,, *Polytrichum aloides*.
,,	,, *Atrichum undulatum*.
,,	,, *Hypnum*.
,,	Male flower of *Polytrichum*.
,,	Conceptacles of *Marchantia polymorpha*.
GIBSON, J. F.,	Section of Aberdeen Granite polarized.
GOLDING, W. H.,	Arborescent Crystals of Silver and Gold.
,,	Elytron of Diamond Beetle.
GRAY, H. J.,	Leaf of Correa, stellate hairs.
GREGORY, JOHN,	Petal of *Correa stricta*.
GUIMARAENS, A. DE S.,	Acari of Rabbit, *Listrophorus gibbus*. ♂. ♀.
,,	Sea Horse, *Hippocampus brevirostris*.
HAILES, H. F.,	Chelifer.
HAINWORTH, W.	*Volvox globator*.
,,	Water Fleas, *Daphnia*.
HIND, F. H. P.,	Gold Dust from Australia.
HOPKINSON, J.,	Young Oysters, *Ostrea edulis*.
HOVENDEN, C. W.,	Marine Algæ, *Polysiphonia fastigiata*.
HOVENDEN, FRED.,	Foraminifera from the Atlantic Ocean, 2,000 fathoms.
HOW, JAS.,	Palate of *Loligo vulgaris*.
,,	Spicules of Gorgonia.
,,	Palate of *Haliotis tuberculata*.
,,	*Nummulites lævigatus*.
INGPEN, JNO. E.,	Absorption spectrum of Chlorophyll.
JACKSON B. D.,	Winged seed of *Cybistax*.
,,	*Volvox globator*.
JOHNSON, J. A.,	Blossom of Yew Tree.
KIDDLE, E.,	Eggs of Parasite of Reeves' Pheasant.
,,	Seed of *Nemesia versicolor*.
,,	Drawings of Ancient Egyptian Jewellery.
,,	Photographs in Abyssinia, Magdala, &c.

LEE, HENRY, F.L.S.,	Marine Algæ, *Polysiphonia urceolata*, with capsules.
LOOF, S. A.,	Elytron of Diamond Beetle.
LOY, W. T.,	Section of Blow Fly.
MCINTIRE, S. J.,	Wing of *Sangala gloriosa*, a moth from Central America.
,,	Flea, *Pulex irritans* (alive), and Red Spider, *Trombidium.*
MARTINELLI, A.,	Electric Spark discharged between Graphite terminals.
MEACHER, J. W.,	Heart of Water Snail, *Planorbis* × 56.
,,	Tank Life (*Stentor*, &c.)
NEIGHBOUR, B.,	*Reseda odorata.*
,,	*Funaria hygrometrica.*
,,	*Bellis perennis.*
NELSON, JAS.,	*Melicerta ringens.*
NEWTON, E. T.,	Eye of Frog, nerves of the cornea, stained with chloride of gold.
NORTHEY, M. D.,	Scale of Perch polarized.
PERRY, F. J.,	Weevil, *Coneatus Tamarasi.*
QUICK, G. E.,	Head of Gnat.
,,	Gizzard of Cockroach.
,,	Tongue of Butterfly.
,,	Section of Human Kidney.
,,	Transverse section of Rush.
,,	Photograph of Shrewsbury Cathedral.
REEVES, W. W.,	*Batrachospermum monoliforme*, var. *pulcherrimum*, a Confervoid Alga from Devon.
RICHARDS, E.,	A selection of Spicules of Gorgonaceæ, illuminated by the new Pocket Lamp and portable microscope body.
ROBINS, EDMUND,	Gemmules of Sponge.
ROGERS, J.,	Wings of the Gnat
ROGERS, J. R.,	Crystals by Polarized Light.
,,	Citric Acid, Cane Sugar, Sugar of Milk, Maple Sugar, &c.
ROGERS, T.,	Polycystina, *Astromma Aristotelis.*
,,	*Anguinaria spatulata.*
RUSSELL, JAS.,	Epistylus.
,,	*Hydra viridis* and *H. vulgaris.*
,,	Circulation in *Anacharis.*
RUSSELL, T. D.,	Collections of British Stalk-eyed Crustacea and Echinodermata.
,,	Sepiostaire (Cuttle Fish), horizontal and vertical sections.
SIGSWORTH, J. C.,	Flower of Common Mallow deprived of the Corolla, showing the Monadelphous Stamens with Anthers and Pollen.
SLADE, J.,	Freshwater Polyzoa, *Lophopus crystallinus.*
SMITH, A.,	Capsule of *Ceratodon purpureus.*
,,	Porphyrine, section.
,,	Fossil Foraminifera from cavity in flint.
SMITH, JAS.,	Spider, alive.
,,	Cheese Mites.
,,	Head of Hornet.
,,	Cockchafer.

SMITH, J. A.,	Larva of Ephemera, or Day Fly, polarized.
,,	Circulation in leg of Water Louse, polarized.
SMITH, W.,	Red Water Spider.
STICKSTONE, C. W.,	Lily of the Valley.
SUFFOLK, W. T.,	Fibres of Flax, *Linum usitatissimum*, by Polarized Light.
SWAIN, ERNEST,	Rotifera and Entomostraca, alive.
,,	Bird's Eye Tobacco.
,,	African and other Limpets, and Oysters.
TAFE, J. F.,	Flea, *Pulex irritans*.
TERRY, J.,	Leaf of *Pomaderris apetala*.
WARD, F. H.,	*Polyxenus lagurus*.
,,	*Degeeria Nicoletii*.
,,	*Degeeria cincta*.
WARRINGTON, H. R.,	Pond Life, *Hydra viridis*.
WESTBROOKE, EDWD.,	Pencil Tail, *Polyxenus lagurus*.
WHITE, F. W.,	Sphagnum or Bog Moss.
,,	Pond Life (*Vorticellæ*).
WHITE, T. C,	Artificial Crystals of Hippuric Acid under Polarized Light.
,,	The Pulsation of the Heart and Circulation of the Blood in young Salmon.
WILLIAMS, GEO.,	Illustration of Pond Life (Entomostraca).
,,	Section of Nose of Mouse (injected).
,,	Section of Spine of Echinus, polarized.
WRIGHT, E,	Elytron of Diamond Beetle.
YOUNG, JOHN T.,	Cuticle of *Equisetum sylvaticum*.
,,	Lepidodendron (Transverse Section of Specimens figured in the "Monthly Microscopical Journal," for Feby., 1872).
,,	Pitchstone from Arran.

Mr. Holmes, of 477, Oxford Street, exhibited his patent stereoscopic binocular microscope, which appeared to interest and elicit approval from the members present.

The following opticians also exhibited microscopes, &c.:—Messrs. Bailey, Baker, R. and J. Beck, Moginie, Murray and Heath, Powell and Lealand, Ross, J. H. Steward, and Swift.

Mr. T. D. Russell exhibited a Natural History Collection; Mr. Ernest Swain, Fossils; Mr. E. Kiddle, some *fac-simile* Drawings of Ancient Jewellery of a date 1800 years B.C.; Mr. Rockfort Connor, some Microscopical Drawings of various Vegetable and Animal Tissues.

The London Stereoscopic Company exhibited on the screen some views of various places of interest, illustrating South Africa and the Livingstone Expedition, in the Mathematical Theatre. Mr. Apps exhibited Electrical Experiments in Vacuo, such as Gassiott's Cascades, &c., &c. Mr. How exhibited Micro-photographs and Photographic Views by the Lime Light, varied by the new form of Kaleidoscope as applied to the Lantern.

PROCEEDINGS.

March 22nd, 1872.—*Chairman*—Dr. John Matthews.

The following donations to the Club were announced:—

"The Monthly Microscopical Journal"...	...from the Publisher.
"Science Gossip"	"
"The Lens"	the State Microscopical Society of Illinois.
"The American Naturalist"	...in exchange.
"The Journal of the London Institution"	...from the Librarian.
"The Annual Report and Proceedings of the Geologists' Association"...	the Association.
"The Proceedings of the Literary and Philosophical Society of Manchester" ...	the Society.
"The 22nd Annual Report of the Bank of England Library"...	Mr. Suffolk.
"Conspectus of Diatomaceæ," extracted from "The Lens," 4 Nos.	Professor Hamilton Smith.

The thanks of the Club were unanimously voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. George Daintrey, Mr. Joseph Guyton, Mr. Ernest D. Marquand, Mr. R. H. Pinker, Mr. C. S. Rolfe, Mr. Harry Smurt.

A Paper by Dr. G. W. Royston Pigott, "On a New Method of Ascertaining the Magnifying Power of Objectives," was communicated to the meeting by the Secretary.

The Chairman said there could hardly be a more fertile subject for discussion than that which was the subject of this paper, neither was it possible to overrate its importance, seeing that accuracy of measurement lay at the very foundation of microscopical investigation. He had himself found very little difficulty in ascertaining the magnifying power of any objective by means of a little contrivance of his own—the calliper eye-piece—which was introduced to the notice of the Club soon after he had first brought it out, and the use of which he explained at the time. He felt sure that all the members would join most cordially in presenting a vote of thanks to Dr. Pigott for his paper, especially as they would have the privilege of reading it *in extenso* when printed in the Journal.

The Secretary, in seconding a vote of thanks to Dr. Pigott, drew the attention of the members to the simple method of ascertaining the magnifying power of objectives mentioned by Dr. Beale in his book on the microscope.

A vote of thanks to Dr. Pigott for his paper was then put to the meeting and carried unanimously.

Mr. Green intimated that he had again brought with him his lime light for the purpose of exhibiting his Podura Scale as an opaque object, and he desired to thank several gentlemen who had assisted him in his investigations. Mr. Arthur Cole, of Liverpool, had in a most kind manner sent him some slides very beautifully mounted, and Mr. Topping had also very kindly supplied him with the Podura scales.

The proceedings then terminated with a conversazione, at which the following objects were exhibited :—

Surirella gemma	by Mr. Curteis.
Podura Scales, shewn as opaque objects by the lime light	Mr. Green.
Injected Muscle of Cat	Mr. de Guimaraens.
Rectal Papillæ and Gizzard of Flea	Mr. McIntire.
Euglena viridis	Mr. Martinelli.
Selection of Gorgonia Spicules	Mr Richards.
Injected Lung of Frog	Mr. Topping.

Attendance—Members, 55; visitors, 8.

RICHARD T. LEWIS.

April 12th, 1872.—Conversational Meeting.

Objects exhibited:—

Trachea from Larva of Dytiscus	by Mr. Geo. Williams.
Larva of the Gnat	Mr. J. A. Smith.
Gizzard of Mole Cricket	Mr. Oxley.
Wing of Earwig	Mr. Oxley.
Phillipine Foraminifera	Mr. Hailes.
Spines and Plates, Synapta similis ...	Mr. De Gumiaraens.
Gizzard and Stomach of Cricket ...	Mr. De Gumiaraens.
Amphioxus paradoxus	Mr. Slade.
Section of Sarsaparilla	Mr. Sigsworth.
Meridion circulare	Mr. J. G. Waller.
Injected ova of Toad, transparent	Mr. Topping.
Decomposed Glass	Mr. Richards.
Hippuric Acid	Mr. T. C. White.
Selected Diatoms	Mr. Collam.
Convallaria Arcellum, &c., &c.	Dr. Ramsbottom.
Heliopelta, &c.	Mr. Jaques.
Cup Moss	Dr. Matthews.
Section of diseased Canine Tooth	,,
Scales of Culex maculipennis	Mr. F. H. Ward.

Specimens of crushed quartz and crushed flint, to show the facility with which polarized light discriminates between sand consisting of comminuted quartz and sand consisting of comminuted flint. As examples :—

Sand from River Parrett, Somerset. Principally quartz; about 1 per cent. of flint.

Sand from site of the New Law Courts. Principally quartz; about 1 per cent. of flint.

Lower Bagshot sand from Hampstead Heath. Contains no flint; principally quartz and oxide of iron.

Chert from Portlandian beds, showing the same structure as flint.

Sand collected from a road repaired with flint. Consists principally of flint.

Sand, Blackfoot loam, from Charlton, Kent. Principally quartz, with about 1 per cent. of flint.

Thanet sand from Reculvers. Principally quartz; about 1 per cent. of flint.

Chalcedony from Iceland, showing it to be crystalline silica, bearing the same relation to quartz crystal and massive quartz that fibrous gypsum does to selenite and common gypsum.

Chalcedony from Iceland.

Chalcedonic pseudomorph, showing rotary polarization, by W. Hawkins Johnson.

Present 59 members.

April 26th, 1872.—*Chairman*, Dr. R. Braithwaite, F.L.S., Vice-President.

The following donations to the Club were announced :—

"Science Gossip"	from the Publisher.
"The Monthly Microscopical Journal" ...	,,
"The Popular Science Review"	,,
"The Proceedings of the British Naturalists' Society"...	the Society.
"The first Report of the South London Microscopical and Natural History Club"	the Club.
"The Journal of the London Institution" ...	the Librarian.
One Slide	Mr. T. Rogers.

The thanks of the Club were voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Herbert Curwen, Dr. R. E. Dudgeon, Mr. J. W. Goodinge, Rev. William Law, Mr. S. H. Roberts, and Mr. Edward Tozer.

Mr. J. G. Waller read a paper, entitled "Observations on Fresh Water Sponges," illustrating the subject by diagrams.

The Chairman proposed a vote of thanks to Mr. Waller for his interesting paper, and invited observations from gentlemen present.

The vote of thanks was carried unanimously.

Mr. Charles Stewart said that he feared he had lost a great deal of Mr. Waller's paper owing to the acoustic properties of the room, but he understood him to lay considerable stress upon the external forms of these sponges as a means of identification. He was himself more acquainted with the salt water sponges, and what he knew of these would lead him to judge that mere external form would be itself only a very rough and uncertain method upon which to form a decision. He should also rather fancy that the process which Mr. Waller had described, together with the flaccid condition, was perhaps due to to the condition of the water in which the sponge was, so to speak, endeavouring to grow, although it could hardly succeed in managing it.

Mr. Holmes inquired whether Mr. Waller had observed any cilia on those little bodies which he had mentioned?

Mr. Waller, in reply, said that he had not observed any cilia, and that the motion itself was very slow. He thought Mr. Stewart had misunderstood him in thinking that he relied upon external form as a means of identification. The flaccid condition of the osculum to which Mr. Stewart had also referred was not due to any cause such as had been suggested, for whenever he tested it by touching the sponge he found that it immediately assumed the other condition; and he had taken great care to keep the water perfectly pure at all times during the course of his observations.

The Secretary read a paper by Mr. Furlonge "On a Phenomenon of Binocular Vision in the Delineation of Microscopical Objects."

The Chairman, in moving a vote of thanks to Mr. Furlonge for his communication, expressed his regret at the absence of the President, who would, doubtless, have been able to give some opinion upon the subject.

Mr. B. T. Lowne said that having previously paid some attention to the subject he thought he could do something to explain this very strange delusion, for it certainly was a delusion. In drawing an object with the neutral tint reflector, the image was really seen on the reflector, but it appeared to be just as far behind it as the object itself actually was in front of it; and it would, of course, be seen whether the light was cut off behind the reflector or not, and it would matter not at all whether with the observing eye they saw through the reflector or not, the apparent position of the image would be just the same. That a picture could be drawn in the manner described he would admit, because it would be seen, apparently, on the paper with one eye, whilst the other eye would see the paper and the pencil,—the paper and the image thus seeming to occupy the same place. But in that case great care must be taken not to move the axis of either eye, otherwise the pencil and the object would seem to be continually running away from each other. As the reflector was very close to the eye the image would be moved a very little, although quite enough to cause a confusion of outlines. It was, however, most preposterous to suppose that the image went in at one eye and came out at the other! When an object was drawn through the reflector the observer looked straight through and did not alter the axis of the eye at all, and there was then no difficulty in keeping the pencil upon the image throughout. The ease with which a person could draw with both eyes in the manner described merely depended upon the ease with which he could squint. He should not, certainly, advise anyone to draw objects in this way, because to do so he must squint, and this would be almost sure in the end to damage the eyesight.

Mr. Unwin said that he had repeatedly drawn an object with the wrong eye when he had been too indolent to arrange the illumination properly. He thought that in doing so he must move the eyes about, but this did not matter so long as the axis of the eyes were kept parallel, or rather, in drawing with both eyes they must always make the image and drawing coincide. He did not know that in doing this he squinted. His experience was that when he used both eyes he did not draw so correctly as he did the other way, and that if he drew the object first with one eye and then, without moving, afterwards drew it with the other, he got two drawings.

Mr. Charles Stewart said that on one point he must disagree, and that was as to the eyes being parallel; their axes must, of course, converge. In drawing, as in observing, it was of advantage to keep the left eye open as well as the right, not necessarily for the purpose of seeing with it, but to relieve it from the strain experienced when keeping it shut.

Mr. Lowne quite concurred with Mr. Stewart ; as to the effects in both cases, it, of course, amounted to the same thing, whether the eye was closed or whether it was not used, and there could be no doubt but that it greatly relieved the eyes to have both open when working with a microscope having a single tube. There were two things which might happen when drawing with both eyes—it might happen that both eyes would be converged upon the same object at the same angle, but it would more usually be done by a squint. There was another thing which also occurred to him, namely, that the foci of the two eyes would have to be different, and this would be sure to cause very great fatigue to the eyes. Their axes must, of course, converge, they could not possibly be parallel, and the question was at what angles did they converge ?

Mr. Tafe remarked that there was a convergence of the eyes both in looking through a microscope and in reading a book, and asked whether there was any difference between the two cases ?

Dr. Sansom said there could be no doubt but that there was a difference between the convergence of the eyes in drawing as described and in reading—in the former case the axis of the eye would be a right line, or, rather, the perpendicular line of a right angled triangle, whilst that of the other eye would be its hypotheneuse ; and this would not be the case in reading a book.

Mr. Hainworth inquired whether there would be some variation according to the power used ?

The Chairman thought there might be a little.

Mr. Tafe asked whether the angle at which objects were seen would not render the binocular microscope injurious to the eyes ?

Dr. Sansom said that the angle would be so slight when using the binocular that it amounted to practically nothing.

Mr. R. P. Williams said that if he looked at the image through the neutral tint reflector, and then took it away and substituted an opaque reflector, then when he examined the image on the paper he could not see that there was any difference in the angle ; and he could not see that he squinted at all. He might also mention that once he introduced a piece of paper on the stage of the microscope where he could see it with the non-observing eye, and he drew the object in this way.

Mr. McIntire said that this was the method which he generally adopted in drawing objects, but he was quite conscious that in doing so he squinted.

Mr. Lowne said that as some gentlemen did not seem to understand what squinting was he would just explain it, for he was sorry there should be any misapprehension. It was squinting when two objects were seen under such an angle of convergence as to make them overlap, as described by one speaker,—squinting was when one eye looked straightforward and the other looked at an angle either inward or outward. With regard to drawing upon the stage of the microscope, he had often done it, but should certainly do it no more, because it could not be done without a squint, and he could not squint without injuring the eyes. In looking through the binocular microscope the angle was really very little indeed, because the image was not seen by looking *through* the object-glass, but only at a picture in the eye-piece of the microscope. It must not be thought that a person looked down the tubes through the object glass, for if this was the case the binocular microscope would be a very painful institution, and would very speedily have to be put out of use.

Mr. R. P. Williams said that he did not regard it as a squint at all.

Mr. Lowne was sorry anyone should go away with a wrong impression, but

assured them that there was really a very great difference between the two cases.

Mr. McIntire said that with regard to the binocular he believed the image seen was formed upon the field lens of the eye-piece.

Mr. Unwin exhibited and described an adaptation of the Nachet revolving stage to the mechanical stage of his own microscope, which, he believed, would be found of great utility. Having found the position of the stage in which it was concentric with the objective, and fixed it there, he removed the brass stage plate and substituted a Nachet stage. The advantages gained by being able to do this were pointed out, and it was suggested that it would be very useful to microscopists if makers would determine the concentric position of the stage, and mark it by drilling a hole through the plates when in that position, so that it might be retained there, if required, by passing a pin through the hole.

Mr. T. C. White brought for distribution some sticks of cement, made of bees' wax and resin in equal parts, and melted together, and which he recommended as being very useful in securing glass covers, &c., temporarily when collecting; it was readily melted by heat, and could be applied without further preparation on the spot.

The proceedings terminated with a conversazione, at which the following objects were exhibited:—

Spicules of Hyalonema mirabilis	by Mr. Curties.
Arrenurus viridis (?)	Mr. Fitch.
Cellularia avicularia	Mr. Golding.
Bone of Hippocampus / Quartz Crystals	Mr. Guimaraens.
Hydra vulgaris (alive) / Larva of Ephemera (alive)	Mr. Hainworth.
Snail Spawn on Water Cress	Mr. Martinelli.
Scales on leaf of Heretiera littoralis	Mr. Pett.
Arcyria	Mr. Slade.
Tracheal System of Flea	Mr. Unwin.
Section of Spongilla fluviatilis and S. lacustris	Mr. Waller.
Ctenoid Scales of Sole	Mr. Geo. Williams.

Attendance—Members, 80; Visitors, 12.

May 10th, 1872.—Conversational Meeting.

Diatomaceæ, *Fragilaria Capucina*	Mr. Geo. Williams.
Section of leaf stalk Water Lily	Mr. Oxley.
Head of a Vanessa Butterfly	Mr. Golding.
Marine Life	Mr. T. C. White.
Spiders Hatching of themselves	Mr. Fitch.
Living Micro-lepidoptera	Mr. J. Smith.
Section of a Blue Pearl found in a Mussel	Mr. Topping.
Larvæ of Gnat and ... ... / Lagena sulcata	Mr. Ward.
Pond Life. Arcellum, Tabellaria, &c.	Dr. Ramsbottom.
Sections of Echinus Spines. Acrocladia trigonaria, &c....	Mr. J. Matthews.
Section of Spinal Cord of Sheep, stained	Mr. E. T. Newton.

May 24th, 1872.—*Chairman*, Dr. R. Braithwate, F.L.S., &c., Vice-President.

The following donations to the Club were announced :—

"The Monthly Microscopical Journal"	from the Publisher.
"Science Gossip"	the Publisher.
"Proceedings of the Royal Society," Nos. 132-3 ...	the Society.
"The American Naturalist," for March and April	in Exchange.
"Proceedings of the Geologists' Association" ...	the Association.
"Proceedings of the Literary and Philosophical Society of Manchester," for March and April	the Society.
"The Lens"	in Exchange.
"The Journal of the London Institution"	the Librarian.
"The President's Address and the Reports, &c., of the West Kent Natural History, Microscopical, and Photographic Society"	the Society.
12 slides	Mr. John Rogers.

The thanks of the Club were unanimously voted to the donors.

The following gentlemen were balloted for and unanimously elected members of the Club :—Mr. W. H. Bennett, Mr. George J. Burch, Mr. Ernest Hinton, Mr. W. H. P. Sheehy, Mr. Ernest Schlœsser, Mr. Henry E. Symons, F.R.M.S., Mr. Henry L. Sequeira, M.R.C.S.

Dr. John Matthews called the attention of the members to a contrivance of his own, of which he had given some hint at the ordinary meeting of the club in March last. On that occasion, it would be remembered that a paper was read on behalf of Dr. Pigott, descriptive of a new instrument of his, which he called the "cratometer," and which was designed to measure the linear magnifying power of objectives; and it would also be remembered that he (Dr. Matthews) said at the same time that he had produced an instrument, the "calliper eye-piece," by which he had been enabled to do this very simply and easily without any reference to mathematical formulæ. Accurate measurement was at the root of all useful scientific research, and was especially important in observations with the microscope, and it was most desirable that every observer should append to drawings of objects the exact magnifying power employed. Their President, Dr. Beale, had set them an excellent example in this respect, never giving a figure of any object without specifying the number of diameters by which it was magnified. It was, however, no easy matter to do this. The usual method was to put the objective and object in their places, and compare the magnified image, seen by one eye, with the scale marked on a foot-rule placed at the same distance as the object, and seen at the same time with the other eye, so as to arrive at an approximation to the actual proportionate enlargement. He had himself thought it better to estimate both these measurements with one eye only, and at the same time, and he had been enabled to do this very successfully by the instrument now brought before their notice, and which was a modification of his "calliper eye-piece." He had used first of all two of Quekett's indicators together in the eye-piece, and then placed a stage micrometer instead of the object, but he found that this was not made so as to enable one of the points to be moved with sufficient precision. He had, therefore, substituted for this arrangement one of Jackson's eye-piece micrometers, removing the glass scale, and had inserted the two points into the body of it. The points were each propelled by a screw of known value, and repelled by a spring. In this instance the

value of the right hand screw was exactly 50 threads to the inch, and its head was divided into 10 parts; the left hand screw was only used for adaptation. In using this apparatus it must first be adjusted so that the points were seen in exact apposition; they must next be separated a known distance, say $\frac{1}{10}$ inch, then place a micrometer on the stage and ascertain exactly how many of its divisions are embraced by the points. Suppose, for instance, that the points were separated $\frac{1}{10}$ inch, and that they were found to embrace $\frac{9}{500}$ inch of the micrometer scale, the proportion which these bore to each other would be obviously $\frac{9}{500}$ in. to $\frac{1}{10}$, *i.e.*, $\frac{50}{500}$ in., or about $5\frac{1}{2}$ to 1, and this, multiplied by 10—the length of the tube in inches—gave him, in the case of the objective to which he alluded, a number which agreed within one of the power assigned to it by the maker, and which he conceived to be exact. In the case of a $\frac{2}{3}$-inch objective, the points set as before mentioned, included $\frac{5}{500}$ in., and the proportion of this to the $\frac{50}{500}$ in., multiplied by 10, gives 100 as the power of the objective. The $\frac{1}{2}$-in. objective gave $\frac{3}{500}$ between the points at the same distance, and the proportionate number in this case was (nearly) $16\frac{1}{2} \times 10 = 165$, and so in the same manner the power of any other objectives might be ascertained. The ease and facility with which this was done was remarkable, and it was so simple that it was scarcely possible to make a mistake. The value of this method also was such that the power of the eye-pieces could also be very easily ascertained, conversely, and another advantage was that the arrangement did not in any way detract from the value of the apparatus as a calliper eye-piece for measuring objects in the ordinary way. There was no necessity to be confined to any special distance of the points, so that if the distance at any time were found to form a fraction, it was easy to draw out the tube sufficiently to make it an even proportionate part, and add that quantity in the estimation.

The Chairman said that all present would be glad to receive this very interesting communication from Dr. Matthews, and to examine the ingenious little piece of apparatus which had been brought for their inspection; the calliper eye-piece would no doubt be remembered, and this adaptation of it would add very much indeed to its usefulness. He noticed, on looking through it, that there was a little difference between the two points

Dr. Matthews explained that he had at first met with some little difficulty as to the pointing, and the method now adopted was suggested by Mr. Hislop. A small piece of balance watch spring was broken by a blow with a hammer upon a convex surface; the broken ends gave very sharp points, although perhaps they might only appear as such when seen in profile in one particular direction.

Mr. Ackland thought that the instrument exhibited by Dr. Matthews was certainly very ingenious, but was of opinion that all it accomplished could be done equally well without any apparatus at all. The first thing he would do would be to ascertain the apparent size of the field of view by drawing it upon paper by means of a "Beale's reflector" at a distance of 10 inches, and when this was once done accurately it would enable anyone at any time to ascertain the exact magnifyi g power of any objective. Suppose, for example, that the diameter of the field so ascertained measured exactly five inches by a rule. Then place a micrometer upon the stage, and read off the number of hundredths of an inch filling the field, then let this number = m

diameter of field of view = v

and magnifying power = m

$$\text{then } m = \frac{1}{m \times \frac{1}{v}}$$

and the magnifying power could be immediately found by a table of reciprocals, and a simple multiplication. Another plan, requiring no calculation, is to obtain an eye-piece micrometer so ruled that when placed in the eye-piece the same number of divisions fill the field of view as there are tenths of an inch in that field when drawn at 10 inches, as above described. In using this arrangement, multiply by 10 the number of eye-piece divisions that cover one hundredth of an inch of the stage micrometer, and the result obtained is the magnifying power. Thus, if 41 eye-piece divisions exactly cover one hundredth of the stage micrometer, the magnifying power would be shown to be 410. This method requires a separate scale for each eye-piece employed.

The Chairman thought that the scale was a very simple contrivance.

Mr. B. D. Jackson inquired whether Dr. Matthews used an absolute tenth of an inch, or whether he took steps to counteract the magnifying power of the eye-piece.

Dr. Matthews said that the advantage of his plan over that just proposed was that it could be applied to any eye-piece, and was not adapted merely to the one for which it was made. The $\frac{1}{10}$ in. was increased by the eye-piece, and varied with the power of the eye-piece, but he was not bound to adopt this particular distance; any other known distance would do equally well, and as the value of the right hand screw was 50 threads to the inch, and the head was divided off into 10, he could adjust the points with great accuracy.

Mr. Ackland observed that inasmuch as the space employed by Dr. Matthews was a portion only of the field of view, any error which might occur would be increased in proportion to the ratio of the space between the points to that of the diameter of the field.

Mr. S. J. McIntire said that he had for a long time adopted a plan similar to that suggested by Mr. Ackland, but had done so in what he thought was a more simple way, without the use of any tables or complex formulæ. His method of procedure was as follows:—First ascertain accurately the apparent diameter of the field of the eye-piece, and reduce it to thousandths of an inch. Next place the micrometer on the stage and read off the number of divisions which measure the diameter of the field, reducing them also to thousandths; then divide the number of thousandths in the apparent diameter, by the number seen on the stage micromoter, and the quotient will be the amplification required.

E.g., if the field apparently measures 5 in., and $\frac{25}{1000}$ in. are seen on the stage micrometer, the sum will be

$$\frac{5000}{25} = 200$$

or should the field be $7\frac{1}{2}$ in. and $\frac{25}{1000}$ in. be seen on the micrometer, it would be

$$\frac{7500}{25} = 300$$

the amplification in these two cases being thus 200 and 300 diameters respectively.

The Chairman thought that Mr. Mc Intire's plan was a very simple one, and one which could be followed by anyone.

The Secretary announced that Mr. Richards had brought for exhibition a tube with a glass end, which was placed over the objective of his microscope for observing objects under water.

Mr. Richards said that this arrangement had been found very useful in connection with his erector for dissecting objects under water.

Dr. Dudgeon mentioned that in the "Quarterly Journal of Microscopical Science" for last July he had described a tube similar to that now exhibited; also in "The British Medical Journal" it was referred to, and described by the Editor last month, and was highly recommended for use in examining urine or morbid secretions with high powers.

Mr. Richards explained that the tube he had with him was more especially adapted for use with low powers in connection with the erector.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Eye-piece Micrometer	by Mr. Ackland.
Series of Coal Slides	Mr. Daintrey.
Pond Life	Mr. Golding.
Method of Viewing Objects under Water...	Mr. Richards.
Arachnoidiscus Ehrenbergii...	Mr. Tafe.
Transparent Section of Injected Kidney	Mr. A. Topping.
Gizzard of Goerius Oleus	Mr. T. C. White.
Cuxhaven Deposit	Mr. Geo. Williams.

Present—members, 63; visitors, 4.

R. T. Lewis.

PLATE I. AND II.,

ILLUSTRATING W. H. FURLONGE'S PAPER "ON THE INTERNAL STRUCTURE OF PULEX IRRITANS."

PLATE I.

Fig. 1.—Reticulated structure of first stomach.
Fig. 2.—The gizzard.
Fig. 3.—The rectal papillæ.
Fig. 4.—Tracheal enlargement in upper tarsal joints of the third pair of legs.
Fig. 5.—Female organs of reproduction—end view.
Fig. 6.—Male ditto—A., end view; B., lateral view.
Fig. 7.—Prehensile organs and sheath plate.
Fig. 8.—Lateral view of male reproductive organs, showing extrusion of penis sheath and penis.
Fig. 9.—Extremity of penis sheath—open.
Fig. 10.— „ „ —closed.

PLATE II.

Abdominal tracheal system of the Pulex irritans.

On the "Illuminator Hand Microscope."

By Dr. Guy, F.R.S.

Communicated by Mr. James How.

In submitting to the Quekett Club, at the request of Mr. James How, some account of the instrument to which I have given the name of the "*Illuminator Hand Microscope,*" I begin by pointing out what I deem new in the parts of the instrument, and in the instrument as a whole.

There is something of novelty in the substitution of what may be fitly termed a *Glass Lieberkühn* for a metallic one; but it is, I believe, a quite new expedient to make the Lieberkühn a fixed part of the microscope, and in such sort that it may be a matter of perfect indifference whether the object under examination is transparent or opaque.

Again, it is no new thing in my own practice to mount microscopic objects on flat disks of crown glass, and so place them in a hand microscope that they may be viewed by any number of persons in succession, without possibility of disturbance. But objects so mounted on disks are new as articles offered for sale to the public.

Then, as to the instrument considered as a whole:—A hand microscope is not new in this year 1872, though I believe it to have been a novelty when I first used it for class purposes in the year 1859, now 13 years ago. And you all know that my esteemed colleague, Dr. Beale, has more recently made good use of the form of the hand, or class, microscope adapted to evening use by a lamp mounted on the same stand as the microscope itself.

A hand microscope, then, is no novelty. But a microscope that can be used in the same way, and with the same facility as an opera-glass or field-telescope, which does not require to be pulled to pieces and set up afresh each time it is used (as is the case with so many cheap microscopes), which deals exactly in the same way

with the *opaque* as with the *transparent* object, dispensing with the mirror and condenser, and throwing upon the opaque object so clear and brilliant a light that it can be seen in its true colour, form, and texture, by the common light of day, and by the light of a common candle at night; which admits of a prompt change of a very large class of objects, and a consequent quick passage of the instrument from hand to hand in the class-room, the village school, or the social gathering—this is a novelty to which it is allowable to attach some importance.

Perhaps I shall show the use and value of the instrument best, and so give an additional interest to what would otherwise be a dry description, if I briefly narrate the circumstances that led me to adopt this new combination.

I was making a short visit to a country house of considerable pretensions, when I saw lying on the table in the drawing-room two boxes, each containing the well-known cheap microscope, with all its disjointed parts and teasing complications. The instruments were rarely looked at, and still more rarely put together for use; for the functions of the several parts were not understood, the putting them together was a puzzle and a trouble; and when the stem of the instrument was at length screwed into the hole in the lid, the mirror and condenser in their places, and the stage fixed, the object, if transparent, was not easily arranged, illuminated, or got into focus, and, if opaque, was still harder to deal with. On examining these instruments, some small element or other of the combination was, in each case, found missing. Even when the instruments were fairly in their places, the observer was teased and tortured by the smallness of their parts, the eyes wearied by the attempt to discern objects through apertures so minute, and on a field so small, and the neck strained and fatigued by the stooping posture. The consequence of all this complication, trouble, and fatigue was, that either instrument remained for months in its box untouched; and, as was said by the poet Cowper of a very different matter—

> "And like an infant troublesome awake,
> Was left to sleep for peace and quiet sake."

And yet all the while the owners of the instrument were by no means indifferent to the pleasure and instruction which a workable microscope is so well fitted to afford; and I became very

desirous to supply them with some more useful, practical, and ornamental instrument. With this intent, I took with me, at my next visit, the hand-microscope which Messrs. Powell and Leland had made for me some years since, leaving behind sundry fittings which I need not now describe. I had had good experience of this instrument in my class at King's College, and I now found that, even when restricted to transparent objects, it was equally useful in small social gatherings. Having some experience of the sort of pleasure afforded by the good binocular microscope brought to bear on popular objects, I found the enjoyment far greater when I substituted this hand, or class, microscope for it. The ease with which the objects mounted on the circular disks were changed, and passed from hand to hand, and the unconstrained posture, gave an altogether new character to the entertainment; and the pleasure afforded was so great that it acted upon me as a strong inducement to find some easy means of dealing with opaque objects. I began my search with a false step. I saw, at first, no better means of throwing light upon the object than the old condenser working in a hole at the end of the instrument. The attempt was a failure, and I became more desirous than ever of finding some expedient by which my instrument might be restored to that simplicity and readiness of use which I had always looked upon as one of its greatest recommendations when applied to transparent objects.

I accordingly put myself into communication with Mr. George Smith, foreman to Mr. How, explained the object I wished to accomplish, and the way in which I thought it might be brought about. The result of our consultations and trials was the *Illuminator*, or *Glass Lieberkühn* of which I have been speaking. It is a plano-convex lens, bored with a central aperture, and converted into a concave mirror, by silvering its convex surface. On trial, we found that an opaque object placed in the focus of the rays reflected from this mirror was brilliantly lighted, and clearly seen, in good relief, even in dull daylight, or the flame of a common candle.

By this simple expedient, of which the effect much exceeded my expectations, my hand or class microscope was restored to that simplicity, which, as I have already stated, was with me one of its chief recommendations. I will not now speak of the improvements which may possibly be made in the shape of the Illuminator, nor of certain developments of which the instrument is obviously

susceptible. Nor will I take up the time of the Society by describing the successive steps by which my employment of a disk of glass for receiving metallic sublimates (the most important advance, as it has proved to be, in the modern science of micro-chemistry), led me first to the use of a Codrington lens, then of the compound microscope, as a class-instrument, admitting of being passed from hand to hand, without displacement or disturbance of the object exhibited.

Suffice it to say that I am now in a position to state, as the result of some experience among groups of persons in society, and in school-rooms, no less than in the hands of individuals working in the closet or in the field, that we have in the *Illuminator Hand Microscope* a most simple, facile and effective instrument of entertainment, instruction and research.

Recent Observations on Diatomaceæ.

In the "Lens," a quarterly Journal of Microscopy published at Chicago, U.S.A., are three consecutive papers entitled "Conspectus of the Families and Genera of the Diatomaceæ," by Professor H. L. Smith, which are worthy of attention. A short critical notice of this conspectus, by Mr. F. Kitton, appears in "Grevillea" No. 4. In the first number of the "Lens," Mr. S. A. Briggs communicates a list of the Diatomaceæ of Lake Michigan.

It has been regretted by many workers in Diatomaceæ, with limited means, that the valuable memoirs published from time to time by Herr Grunow, in the transactions of foreign societies, are beyond their reach. To meet this difficulty, the Editor of "Grevillea" has commenced the publication of *fac simile* figures, with translations of the descriptions in that Journal. The first plate of the Novara Diatoms has appeared, and the remaining two are printed ready to follow. It is proposed hereafter to publish figures and descriptions of the species in the Vienna Transactions. Additional critical observations will be made, as occasion may require, by Mr. F. Kitton, the translator of the descriptions.

Old Nettle Stems and their Micro-Fungi.

By M. C. Cooke, M.A.

As children once burnt have a wholesome dread of the fire, so children once stung have, for a time at least, a wholesome dread of the nettle. It would be some consolation to the school-boy, just smarting from the consequences of an unlucky fall into a bed of nettles, to know that alive or dead the nettle has a complete host of enemies, blighting it whilst living, and preying upon it in decay. To children of more mature age it may not be without interest to be informed of some of the foes of the nettle, which thrive at the expense of its dead and decaying stems. We are not aware that anything of the kind has been attempted, and despite the objections of those who advocate a more strictly scientific method, we will collect together a few observations on certain microscopic fungi having a common habitat, so that for this occasion the bond of union will not be one of structural relationship, but that of one common home.

It has often been objected by novices that however beautiful and instructive the minute fungi may be, they don't know where to seek them, or when found to determine their names without some considerable previous knowledge. There is much of truth in this, or we had not made this little experiment on the popular side of a rather dry and difficult study.

Assuming the desire on the part of the student to gain some knowledge of fungoid life, and that he has provided himself with a copy of the "Handbook" for reference as to the position, relationship, and technical characters of the species to be here described, little more is required save the microscope, the pocket lens, and a bed of old nettle stems in a damp situation. With these provisions a few weeks of good work is sure to follow, especially if pursued in the early spring, and with a resolute determination. It is not our intention to include any of the species which are parasitic on the green plants, but those only that develope themselves

on the dead stems, thus limiting the period of observation to one habitat, and one time of the year. This limitation promises far better results than a more desultory method, and the experience so gained will lead thereafter to a wider field, and more extended researches.

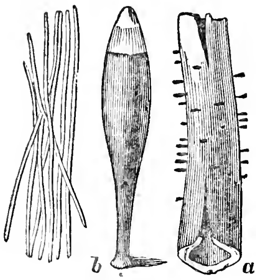


Fig. 1.

To commence with one of the most singular of the fungi found on old nettles, we will name *Acrospermum compressum*, because it is also one of the largest, and most prominent to the naked eye, and the most distinct that we shall have occasion to name (fig. 1). It has the appearance of little black flattened clubs, from one-and-a-half to two lines high, opening at the apex, and discharging therefrom long thread-like spores. A number of these clubs are usually found together, and their size renders them rather conspicuous. The character of the spores, as well as the form of the perithecia, is so distinct, that there can be no fear of confounding this with any other fungus found in a similar locality. The spores are not contained in asci, or the clubs might be supposed to belong to the *Sphæriacei*, but hitherto no more perfect or complete condition has been observed. It is just possible that a better acquaintance may hereafter lead to the discovery of some condition in which asci are produced.

Hitherto in one locality only we have found on very old and decaying nettle stems a species of *Dinemasporium*, which seems to be specifically distinct from any previously described, although included in the "Handbook" as a variety of No. 1365. This is not the place to enter upon the discussion of the limits of species in general, nor the distinctions in this particular instance, but our own opinion is strongly in favour of separating the form on nettle stems from that found on grasses. It may be observed that this fungus appears at first as rigid black bristles, bursting through the cuticle in a short linear series; soon afterwards, especially in moist places, or during damp weather, in early spring, intense black, velvety elevations, from one to two lines in length, burst through and appear on the surface. These assume an elongated cup-shape when dilated, closed when dry, surrounded by stiff, erect black bristles. The hymenium is the interior of the cup, in which is produced a

great number of hyaline, sausage-shaped spores, sometimes straight, but often curved, containing one or two nuclei, and furnished at the extremity with a delicate, hair-like appendage. This appendage to the spores is the chief feature which distinguishes the genus *Dinemasporium* from *Excipula*, and both are very much like hispid *Pezizæ* with naked spores, or spores *not* contained in asci. Whether this is sufficient in itself to justify the maintenance of two genera is very doubtful ; in fact, so are all generic distinctions founded solely on slight differences in the character of the spores. It might be urged with equal justice that *Valsa taleola* should be constituted a member of a new genus distinct from that which includes *Valsa leiphemia*, because of the similar hyaline appendages to the spores of the former which are absent in the latter. Hereafter it may possibly be demonstrated that the majority of species now included under *Dinemasporium* and *Excipula*, as well as *Solenia* and *Cyphella*, are conditions of Pezizoid fungi.

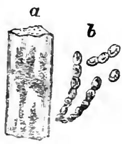


Fig. 2.

The sooty black patches on old nettle stems which are so common in spring are *Torula herbarum*. This is a very good example of a large genus (fig. 2), having much external resemblance to the black moulds, but structurally belonging to the *Coniomycetes*. The whole fructifying surface is exposed, and in this particular instance looks exceedingly like a patch of soot sprinkled on the rotting stems, it may be a quarter of an inch, or it may be two or three inches in length. A little of this sooty fungus examined carefully with a power equal to three hundred diameters, will reveal innumerable threads of dark sub-globose spores attached to each other in a moniliform manner, like strings of beads, but if a drop of water touches them all these spores separate from each other, without a trace of their mode of growth, and in that condition it would be exceedingly difficult to determine the genus or order to which the fungus belongs.

Another fungus belonging to the same order, and with a similar structure, has also been found on nettle stems in the month of October. This is *Septonema elongatispora*. The threads in this instance also consist of spores attached end to end as in *Torula*, but, instead of being simple, the spores are cylindrical, with one or two septa, and quite colourless. The tufts are effused over the stems, giving them a whitish mouldy appearance, very different to the sooty patches of *Torula*, and more like those of *Dendryphium griseum*.

Although this and some other species here enumerated have only been detected on nettle stems, it does not follow by any means that they are confined to such a habitat, or that some other allied species found on other herbaceous plants may not also occur on nettle stems. At present our knowledge of the distribution of these minute forms is too limited for generalizations of this kind.

Externally, and to the naked eye, resembling a very thin patch of the *Torula*, another, and widely different fungus, may be found in a similar location. In this instance the coating is so thin that it only gives a greyish appearance to the stems, the black threads being sprinkled about in patches two or three inches in length. When held up between the eye and the light, and examined by a pocket lens, the twig appears velvety with erect black hairs, an appearance never presented by the dense growth of the pulverulent *Torula*. This is the general appearance of two species of *Dendryphium*, a genus of black moulds distinguished by the jointed threads being branched in the upper portion, bearing at their apices septate spores, which are often attached end to end in a series. In one species, the fertile branches are radiating, or form a dense head, and the septate spores are variable, with the joints quadrate. This is called *Dendryphium comosum*. In the other species, *Dendryphium curtum*, the branches are shorter, and forked; the spores are curved, with from three to seven septa, constricted at the joints. The shorter forked ramuli, and the much constricted articulations of the spores, are characteristic of this species. Both of them are found on old nettle stems, as also a third species—*Dendryphium griseum*—which is very different in its appearance to the naked eye. In this latter the stems are covered in patches of some extent, with a bluish-grey bloom, something like the bloom of a ripe plum. The threads are but slightly branched, and the spores are cylindrical, with a little point at each end, and arranged in chains; they are at length uniseptate, and colourless. There is something so very different in the appearance of this species and its colour, that at first it would scarcely be recognized as belonging to the same genus as the two preceding. It is often very common amongst the *débris* of an old bed of nettles.

Another black mould may be named in this association, which, though perhaps much less common, is even more beautiful (fig. 3). It is *Arthrobotryum atrum*. In this instance the common stem is composed of jointed threads, which are attached together

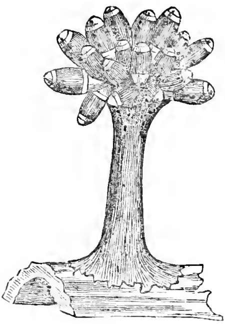


Fig. 3.

side by side, and expand at the apex into a head or tuft of large, somewhat elliptic spores. These spores are divided unequally by transverse septa, the central portion being coloured brown, and the extremities colourless. By a little careful manipulation this mould may be examined *in situ*, although when such a high power as a third or a quarter-inch objective is required for an opaque object patience and perseverance are requisite. We have found that a third with a small nozzle, bevelled at the edge, on the continental rather than the English method of mounting the lenses, is the most effective. Such an objective admits of more light being thrown down upon the mould by means of a bull's eye and side reflectors than can be accomplished with the usual English objectives. Without intending any invidious allusion to one maker rather than another, we may be permitted to state that such an objective was made for us on the above plan by Mr. Swift, at a moderate price, and has succeeded better than any other plan we have adopted to secure the examination of such opaque objects as moulds, and other microscopic fungi, in their natural condition, by means of high powers. Doubtless the lime light recommended by Mr. Green for the examination of diatoms would be a valuable adjunct, although we cannot as yet speak from experience. It cannot be urged too often or too strongly that, in order to see objects as they really are, they should be viewed by the opaque method, and *not* by having the light thrown through them. To confide in such a mode as the latter may save trouble, but it is only a delusion and a snare.

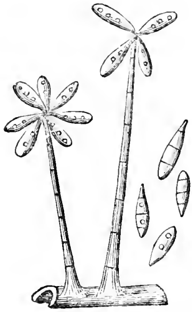


Fig. 4.

Another black mould found by Mr. Broome, on the old stems of the nettle, is *Acrothecium simplex*. In this genus the jointed threads are either simple or branched, with the spores clustered at the apex (fig. 4). In the present species the threads are simple and flexuous, bearing a few almost clavate spores at the apex. The threads are brown, and the spores slightly coloured, divided transversely by four or five septa. Mr. Broome found this species in the month of December, and as there is no other record of it, pro-

bably it is rather uncommon. The tufts of spores at the apex of the simple dark brown threads are sufficient to distinguish it readily when met with. Like its congeners it appears in thin velvety patches on the stems, and is scarcely visible to the naked eye, except in the darker tint of the patches.

There is a very pretty and interesting group of fungi which are well represented on old nettle stems, possessing a high organization, and, when fresh, often beautiful. These belong to the genus *Peziza.* It may be premised that the substance of these fungi is between fleshy and waxy, that they are more or less cup-shaped, either smooth or hairy externally, sometimes sessile and sometimes stalked, and that the sporidia are contained in asci embedded in the substance of the cup. The method employed for their examination and preservation, with some particulars of their structure, will be found in a previous communication on "Nucleated Sporidia" (vol. ii., p. 251).

It is one of the "commonest objects" to see old stems of nettle sprinkled from the base upwards with orange points about the size of pin's heads. When the weather is damp these little points are very prominent, swollen, and gelatinous, crushing readily under the finger like jelly, and of a bright orange colour, giving a distinct colour to the stem, so that even at a distance the orange tint may be recognized. This tremelloid orange fungus is the precursor of a species of *Peziza* of the same colour, consistence, size, and general appearance, of which it is now regarded as the conidiiferous condition. If one of the orange pustules, whilst moist and tremelloid, be subjected to examination, it will be found to consist ot delicate branched threads, immersed in the gelatin, and bearing on their tips, at the surface of the masses, a great number of minute colourless spermatia or conidia. This was formerly named *Fusarium tremelloides*, and was for a long time included amongst the tremelloid fungi as a *Dacrymyces.* In this condition there are no traces of asci. At a later period, and what would at first seem to be the same fungus, so identical in habit, size, and colour, makes it appearance. The only distinction between them which even a pocket lens will reveal, is that of a depression in the centre of the pustules, which have now assumed a cup-shape. Crushed in a drop of water under the microscope, the branched threads are no longer to be seen, but instead thereof transparent elongated sacs, or asci, each containing eight small sporidia. This is *Peziza fusarioides.* On

referring to the "Handbook," it will be observed that this *Peziza* belongs to the section *Mollisia*, in which the cups are sessile, externally naked, and of a soft texture. We recently received a closely allied species on Aster stems from the United States, which was figured and described in "Grevillea" (No. 1, p. 6, fig. 6) as *Peziza assimilis*. In both these, and in some few others which continental authors have associated together under the generic name *Calloria*, the substance is much more gelatinous than in the majority of the species of *Peziza*.

Two or three species of *Peziza* found on these stems are characterized by being hairy externally, and hence they belong to the section *Dasyscypha*. The most common of these is a very pretty little white fungus, covered outside with rather long white hairs. The cups are sessile and minute, seldom open, except in quite wet weather, and even then only partially so. But the most unsatisfactory point in their history is that they always appear to be barren. No author gives any account of the fruit of *Peziza villosa*, and yet all agree in retaining it as a species of *Peziza*, whereas the strong presumption is in favour of its being a *Cyphella*, and unless a perfect hymenium with asci and sporidia can be found it has no title to be regarded any longer as a *Peziza*. Here is one point which may be investigated and settled by any student who takes advantage of this communication to commence the study of microscopic fungi.

Allied to this, but apparently much less common, is a woolly, white *Peziza*, first discovered in Scotland by the late Dr. Greville, and called by him *Peziza plano-umbilicata*. It is gregarious in its habit, small and sessile, wholly white, becoming expanded, and quite flat, with a little dimple in the centre. The hairs around the margin of the cup are very regular, forming a delicate fringe. As it grows old, it assumes a yellowish tint. Although in many points this closely resembles the preceding, it will not be a difficult matter to distinguish the one from the other, since this soon becomes expanded, and has asci and sporidia, so that it is a true *Peziza*. A common white-stalked *Peziza*, with a woolly exterior, may sometimes be found on nettle stems, but must not be confounded with this. It is *Peziza virginea*, and grows freely on all twigs that are covered over with dead leaves, in damp spots.

Another species belonging to the same section is *Peziza sulphurea*. This is also sessile, but much larger than the preceding;

sulphur-coloured, and woolly externally, approaching to brown, especially when dry, with the disc or inner surface of the cup of a pallid hue. This is a very pretty object, but the colour varies considerably in its depth and brightness. The asci contain eight fusiform sporidia, which seem to be sometimes divided transversely by three septa, but probably this may only be a division of the endochrome. It is very difficult at times to make out distinctly the form of the sporidia when still contained in the asci, or the septa when free, if the membrane is very delicate. To assist in this a drop of tincture of iodine should be run in under the covering glass whilst the asci are being examined. The membrane is tinged of a brownish colour by this means, and is often rendered quite distinct.

The remaining species of *Peziza* found on old nettles belong to the section *Hymenoscypha*, in which the cups are stipitate, and somewhat membranaceous, and though smooth internally the margin is often toothed or fringed. The *Peziza inflexa* of Bolton is a pretty species, of a dirty yellowish white, with the margin of the cup beset with regular triangular teeth. It is figured by Bolton in his "Funguses of Halifax" (plate 106, fig. 2). The marginal teeth are not erect, but bent inwards towards the centre of the cup.

Closely allied to the preceding is *Peziza coronata*, of a nearly equal size, similar in colour and in length of stem, but differing in the margin being beset with a fringe of bristly hairs, instead of the distinct, inflexed, triangular teeth of the previous species. The alliance of these is so intimate that some authors have not hesitated to regard them as forms of the same species, whilst others maintain that their differences, though minute, are permanent.

A yellow, or brownish yellow *Peziza*, is found on stems of the nettle in Northern Europe, which, from the campanulate form of the cups, has been called *Peziza campanula* (Nees.), but it has not been recorded in Britain. The sporidia in this species are slender, and with from three to five transverse septa. It is found in August and September.

A much more distinct, but by no means common, species is *Peziza striata*, with the cup turbinate, or top-shaped, of a brownish colour, striate externally, and with a short pallid stem. The margin is always disposed to close inwards, but is not fringed or toothed. The inner surface of the cup is pallid. The sporidia are fusiform, and without any indication of septa. It is so much addicted to

making its appearance on stems of nettles that Persoon described it under the name of *Peziza urticæ*. When fresh there is a pruinose, or frosted character about the margin of the cup.

It is quite probable that other species besides those now enumerated may be found growing on such a good-natured host as old nettles seem to be. Of later years a number of species of the old genus *Peziza* have been removed and constituted a new genus, under the name of *Helotium*, chiefly on account of the disc being always open, and often convex, as well as some minor distinctions. One species of *Helotium* occurs on nettle stems, as well as some other herbaceous plants; it is *Helotium herbarum*. The smooth waxy cups are whitish with a tinge of ochre, and flattened, or a little convex; the stem is very short, so as not to raise the margin of the cup above the surface of the stems. The sporidia are long and narrow, blunt at the ends, sometimes straight, and sometimes curved, with occasional indications of three transverse septa, which may possibly be spurious.

There are to be found on the same old nettle stems a group of fungi, partaking of such general features in common that we may call them the Nettle Sphærias. The distinguishing mark of this group is that the sporidia are contained in asci, which are enclosed in a more or less carbonaceous perithecium. Reducing this description to more common-place language, it may be said that the whole fungus consists of a blackish receptacle, somewhat like a water-bottle in shape, with a nearly globose body and rather short neck. This bottle is sometimes imbedded and sometimes exposed; sometimes single and sometimes in groups or clusters, or even in confluent masses. The interior of these little bodies contains something very like a minute drop of gelatine composed of long narrow bags of transparent membrane called asci, each of which encloses, when mature, about eight smaller bodies of the nature of seeds, termed sporidia. Mixed with the asci are long, slender, hair-like, colourless filaments, considered by some as abortive asci, but which are termed paraphyses. Such are the Sphærias. There are several species of them found on old nettle stems, and the most important of them will be briefly noticed. First, and commonest, is the gregarious species found near the bottom of almost every old nettle stem that is plucked up. Shining black conical flasks, with a flattened base, collected together by scores, throw off the cuticle and become exposed as they approach maturity. Examined

closely by means of a two-inch objective, these bottle-shaped bodies will be detected having two forms, one conoidal with a short neck, and one flattened with a longer acute neck. These are two forms of the same fungus. The former contains the asci and sporidia, the latter free bodies, much more numerous and minute, which are spermatia. There is still some confusion in the names which are applied to these two forms. It is generally admitted that the acute form, containing spermatia, is the *Sphæria acuta* of Hoffman, but not a complete or perfect Sphæria, and hence called by Berkeley *Aposphæria acuta.* The other form, which contains the asci, is regarded as the perfect condition of the same fungus, and some authors apply to it the name of *Sphæria acuta*, whilst others regard it as the *Sphæria coniformis* of Fries, and apply to it that name. Whichever name is adopted, all seem at least to be agreed that the two forms represent the spermogones and ascophores of one and the same fungus. If the flattened form with the acute neck be examined, by crushing one of the perithecia in a drop of water, its interior will be found filled with a mass of very minute, linear, curved bodies, at first attached to delicate pedicels, and these, produced from the inner wall of the perithecia, are the spermatia. It is probable that they have some function to perform in relation to the fecundation of the sporidia in the other form. The more conoidal, and rather larger perithecia, contain asci, each enclosing eight transparent fusiform sporidia, which, when mature, are divided transversely by numerous septa, and acquire a yellowish tint.

Some two or three years since Dr. Capron, of Shere, first called our attention to a *Sphæria* found by him on old nettle stems, in which the perithecia were far less numerous, more imbedded, and usually covered, except the broad gaping mouth, by the cuticle of the stem. In this instance the sporidia are as long as the ascus in which they are contained, and lie side by side in a bundle, without crossing or interlacing each other. These sporidia are threadlike, and divided by transverse septa into a great number of cells, about equal in length to their breadth, and of a yellowish tint. From examination and comparison we became satisfied at the time that this was the species named by Dr. Rabenhorst *Sphæria urticæ*, but hitherto have only seen it from Shere. This has many points of resemblance to *Sphæria rubella*, which is also very occasionally found on nettle stems, but there are no red spots, and there is none of the pubescence on the perithecia.

Another, and still more singular *Sphæria* was also found by Dr. Capron on nettle stems at Shere, in which the sporidia are different from any other that we have ever seen. The perithecia are depressed and covered by the cuticle, so that only the mouth is visible.

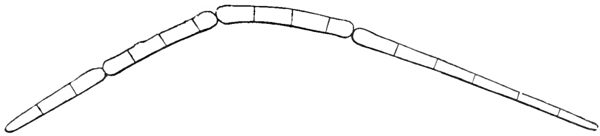


Fig. 5.

In wet weather the perithecia can be readily seen through the cuticle, but when the stems are dry it is almost hopeless to search for this species. The sporidia are also as long as the ascus in which they are contained, crossing each other near the apex, but when free are found to be twice or thrice septate, bent at the constrictions, and again spuriously septate two, or three, or more times in every joint (fig. 5). From the peculiarly angular manner in which the sporidia are bent when free, this species was named *Sphæria ulnaspora*. By comparison with the fruit of *Sphæria acuminata*, common on thistle stems, and the *Sphæria urticæ* and *Sphæria rubella* named above, this will be found markedly distinct from all. It may be noted that whilst in most instances *Sphæria acuta* will be found at the base of the stems, *Sphæriæ urticæ* and *Sphæria ulnaspora* occur higher up, usually about midway of the stem.

Sphæria doliolum is by no means an uncommon species on the stems of umbelliferous plants, and sometimes on old nettles. The perithecia are of a shining black, and concentrically channelled, so that a ridge seems to run round the perithecium, giving it a very distinct character. Sometimes the perithecia are very conical, as in a variety described by Mr. F. Currey as *Sphæria Helenæ*. The sporidia are arranged in two rows in the asci, and are yellowish, almost fusiform in shape, and divided by from three to five septa, with constrictions at each joint. Spermogones are often found mixed with the perfect perithecia, and these contain a great number of minute colourless spermatia. The second joint of the sporidia is sometimes swollen so as to be broader than the rest.

The stems of nettles are often sprinkled so densely with the small black perithecia which nestle beneath the cuticle, as to have a grey, nebulous appearance, which are probably the *Sphæria nebulosa* of old authors, or partly so. These very minute perithecia do not con-

tain asci, but innumerable minute bodies of the nature of spermatia, and the perithecia are therefore the spermogones of some *Sphæria*, and in some instances of *Sphæria superflua*, which is occasionally mixed with, or in close proximity to the spermogones. In this species the perithecia are small and delicate, although twice as large as the spermogonia with which they are associated, and always covered with the cuticle. The sporidia are oblong and colourless, in two rows, and divided across the centre by a septum into two equal cells. The spermogones seem to be, in part at least, the *Phoma nebulosum* of authors.

A group of the old genus *Sphæria* is characterized by the broad orifice of the perithecium, which is flattened laterally, so as to bear some resemblance to a mouth with two lips. These perithecia are usually imbedded in the matrix, so that the mouth only is exposed. Recently this group has been regarded as a distinct genus, from the form of the mouth principally, under the name of *Lophiostoma*, although some authors still hesitate to accept it as a good generic distinction. Two of the members of this group are found on nettle stems; one having been first detected by Dr. Capron, of Shere, a few years since, and described under the name of *Lophiostoma sex-nucleata*. It appears to succeed *Sphæria acuta*, and is often over-looked, from its casual resemblance to the remains of the dispersing perithecia of that species. The old stems on which this species is found are so far advanced in decay that they are usually tender and friable. The sporidia are fusiform, slightly curved, and five-septate, with a constriction in the centre, each articulation contains a single nucleus, from which the name of the species is derived.

The other species is *Lophiostoma caulium*, which is very similar in external appearance, but differing in fruit. The sporidia are also fusiform, and attenuated towards each extremity, often curved, with a greenish tint, and divided transversely by seven septa, exceeding by about one-sixth or one-eighth the length of the sporidia in *Lophiostoma sex-nucleata*. The same species is also found on the stems of *Epilobium hirsutum*, and other herbaceous plants.

There is a very interesting group of *Sphæriacei*, in which the perithecia are of a softer and more waxy substance, usually brightly coloured, of which a new species has recently been described by Nylander, under the name of *Nectria dacrymycella*, which is found in Northern Europe on old nettle stems. The perithecia are orange-

yellow and minute; the sporidia fusiform, and delicately uniseptate. It has not hitherto been met with in Britain.

This enumeration includes the majority of the species of micro-fungi which have as yet been detected on the stems of old nettles in Britain. Formidable as the list may appear, there are two or three others which have been found on the Continent, and which, by dint of perseverance, may still be found in this country. At any rate, we have made good the assertion with which we commenced, that the nettle has a complete host of enemies, blighting it whilst living, and preying upon it in decay. In illustration of the enemies which are parasitic upon it whilst living, we have been unable to devote space equal to that already occupied, leaving out of the calculation all the insect enemies for the entomologist to discuss; but the moulds, cluster-cups, *Septoria*, and other parasites of living nettles, are scarcely less numerous than those which flourish on its decay.

The following is a list of the species of micro-fungi alluded to in this communication:—

Acrospermum compressum. *Tode.*
Dinemasporium *var.* herbarum.
Torula herbarum. *Link.*
Septonema elongatispora. *Preuss.*
Dendryphium comosum. *Wall.*
Dendryphium curtum. *B. & Br.*
Dendryphium griseum. *B. & Br.*
Arthrobotryum atrum. *B. & Br.*
Acrothecium simplex. *Berk.*
Peziza fusarioides. *Berk.*
Peziza villosa. *Pers.*
Peziza plano-umbilicata. *Grev.*
Peziza sulphurea. *Pers.*
Peziza inflexa. *Bolt.*
Peziza coronata. *Bull.*
Peziza campanula. *Nees.*
Peziza striata. *Fr.*
Helotium herbarum. *Fr.*
Sphæria acuta. *Hoffm.*
Sphæria urticæ. *Rabh.*
Sphæria ulnaspora. *Cooke.*
Sphæria rubella. *Pers.*
Sphæria doliolum. *Pers.*
Sphæria superflua. *Awd.*
Lophiostoma sex-nucleata. *Cooke.*
Lophiostoma caulium. *Fr.*
Nectria dacrymycella. *Ngl.*

Notes on the "Black Knot."

By C. H. Peck, Esq., of Albany, New York.

What is black knot? To this question Dr. Fitch, Entomologist of the New York State Agricultural Society, answers: "It is a large irregular black wart-like excrescence which grows upon the limbs of plum and cherry trees, causing the death of all the branch above it and extending down the limb farther and farther every year till the whole branch is destroyed, other limbs at the same time becoming affected in the same manner, and also the limbs of other trees in the vicinity. If it is neglected, it in a few years kills the tree."

The late lamented B. D. Walsh, Entomologist of the State of Illinois, thus defines it: "It is a black, puffy, irregular swelling on the twigs and smaller limbs of plum and cherry trees, and in one instance that came under my observation, of peach trees, making its first appearance in the latitude of New York early in June, and attaining its full growth by the end of July. Usually a tree that is attacked in this manner is affected worse and worse every year until it is finally killed, and where one tree of a group is affected, the malady usually spreads to them all in process of time."

According to our own observations the death of the branch above the excrescence is not always produced by the first attack. In such cases the malady extends upwards as well as downwards. The time of the first appearance of the excrescence is in late autumn, although the external development of the fungus is not manifest until the following May. We have never found it on peach trees.

Let us now see what is written concerning the origin of black knot. Schweinitz, the botanist who wrote the original description of *Sphæria morbosa*, the fungus that develops itself on the excrescence, seems to have been in some doubt concerning the origin of the tumour. In his description he uses these words: "*Hæc massa num sit effectus ictuum Cynipis nescimus, videmus tamen hic*

illic exesum foramen, forte e profundo progressæ." At a later day, in writing upon this same subject in his Synopsis of North American Fungi, he says: "*Paucis annis post, fere omnes destructi sunt, combinato furore hujus fungi et Cynipis.*" And again he says: "*Et in his omnibus Cynipis fungusque inceperunt sævire.*" Thus he constantly associates the insect which he calls Cynips with the fungus, without definitely assigning the honour or dishonour of the mischief to either. We find the following in *Harris's Treatise on Injurious Insects*: "The plum, still more than the cherry tree, is subject to a disease of the small limbs, that shows itself in the form of large, irregular warts of a black colour. Professor Peck referred this disease, as well as that of the cherry tree, to the agency of insects. Dr. Burnet rejected the idea of the insect origin of this disease, which he considered as a kind of fungus. * * * But whether caused by vitiated sap, as Dr. Burnet supposed, or by the irritating punctures of insects, which is the prevailing opinion, they form an appropriate bed for the growth of numerous little parasitical plants or fungi."

Dr. Fitch claims to have made a careful investigation of this subject, and as his observations are quite accurate we again quote from his address: "There has been much speculation as to the cause and true nature of these excrescences. * * Most persons suppose them to be of insect origin. The larvæ of the curculio are almost always found in them, and these larvæ consume nearly all the spongy matter of the warts, but do not touch the little fungus growing on their surface, which remains, forming a kind of shell, after the whole inside is devoured. But as these excrescences are sometimes found wholly free from curculio larvæ and all other worms, it is obvious they are not the cause of their growth. * * Suffice it to say that now, having carefully examined these excrescences from their commencement onward through their subsequent growth, I am prepared to say, with the fullest confidence, that the microscope shows nothing whatever about them, externally or internally, indicating that an insect has anything to do with causing them." Then, after giving his views as to what constitutes a fungus, he says: "We arrive at the conclusion that these excrescences are not of insect origin, and are not a vegetable fungus, but are properly a disease of these trees, in many respects analagous to the cancer in the human body."

Mr. Walsh, whose definition of black knot we have already

quoted, agrees with Dr. Fitch in concluding that the excrescences are not of insect origin. He also claims to have carefully watched the black knot through all its stages from its earliest commencement to its complete maturity. He affirms that he bred from the galls five distinct species of insects beside the curculio, but that not one of these could be considered a true gall maker. He, therefore, very justly concludes that the excrescences are not of insect origin, but of fungoid origin; and this conclusion, we may add, is entirely in accordance with our own view of this subject. Our reasons for adopting this view are briefly these:—

1st. The excrescence itself is similar in structure to other excrescences which are known to be of fungoid origin, and at the same time it is quite dissimilar to most insect galls produced in twigs and young branches.

2nd. The time of its development is opposed to the probability of its insect origin. We are well aware that our knowledge of insect galls is extremely limited, and that here we are treading on dangerous ground and may hereafter be obliged in our turn to apologise to the entomologists, but so far as our observations extend, insect galls are developed in the warmer seasons of the year, *i. e.*, in spring, summer, and possibly early autumn. Those that continue to be the domicile of the young insect during the winter are, so far as we have observed, fully grown in autumn, and do not increase in size the following spring, a character which does not hold good in the case of black knot.

3rd. The fungus is always present with the excrescence, and its mycelium may be detected even in the earliest manifestation of the tumour, and this fungus is never found apart from the black knot. To our minds this alone is a sufficient argument for our belief in the fungoid origin of the excrescence. Who ever heard of any undoubted insect gall being *always* accompanied and inhabited by a fungus? On the other hand, the larvæ of insects are not always present in the excrescence, and of those insects that have been bred from it, none, we are told, have been true gall makers.

Like others from whose writings we have quoted, we also claim to have examined the black knot carefully in its various stages of development, not entomologically it is true, but botanically, from which it is not unreasonable to suppose that we may have observed some details in its development which escaped their notice. We desire, therefore, to express the results of our own observations,

because in one or two points we cannot quite agree with the inferences and conclusions of former investigators.

If the smaller branches of a cherry tree that is suffering from an attack of black knot be carefully examined in November, some of them will be found to be slightly swollen for a little distance immediately below the excrescences. The cuticle of the bark will be cracked open here and there, revealing the soft tissues of the inner bark. If a minute portion of this inner bark be examined by the aid of the microscope, slender jointed filaments or threads may be seen, that have insinuated themselves among the bark cells. These threads are the primary vegetating condition of the fungus, and are known to botanists as *mycelium.* During the winter the enlargement of the branch remains nearly or quite stationary, but with the advent of spring and the renewal of vegetable activity, the tumours increase in size, the chinks in the bark become wider and more numerous, and by the end of May small, dark, green stains are visible in the crevices of the bark. These greenish patches gradually increase in size until in some instances they completely cover the whole surface of the excrescence with a soft, velvet-like coat. Such specimens were once sent to me from the west, where they had been pronounced by a scientific journal to be a *new species* of black knot. A microscopic examination of this greenish coating reveals the fact that it is composed of innumerable upright, jointed, flexuous threads or flocci, which bear upon their summit oval or oblong spore-like bodies, at first simple, but soon becoming one or more septate. This is the first external development of the fungus, and in the systematic classification adopted by botanists it belongs to the genus Cladosporium. This genus, however, we apprehend is destined to be overthrown, its species being only an early form of development of species of Sphæria. Indeed those celebrated European mycologists, Tulasne and Cooke, already deem the very common *Cladosporium herbarum* to be only a condition of *Sphæria herbarum.* And here we have another quite clear case of a similar dimorphism, for I never yet have seen a young black knot excrescence of the cherry tree in spring on which I could not detect the Cladosporium. In a few weeks this Cladosporium growth is succeeded by numerous minute, black, globular bodies, scarcely as large as the head of a small pin. These usually cover the whole surface of the excrescence, and are often so closely crowded together that they partially lose their globose

form. This stage of the fungus development has evidently been mistaken by some for its complete development. In the work of Harris, on *Injurious Insects*, we find the following statement in reference to this fungus; "they come to their growth, discharge their volatile seed, and die in the course of a single summer." And in the *Practical Entomologist* for March, 1866, we find this statement: "Towards the middle of August, the new black knot, having perfected its seed, gradually dries up, and becomes internally of a reddish-brown colour. In other words, like so many other annual plants, it dies shortly after it has perfected its seed." Again, in the March number for 1867, Mr. Walsh says: "I showed that black knot is nothing but an assemblage of minute funguses, which perfect their seed, or 'spores,' as botanists term it, the latter end of July; and that consequently, as this fungus is an annual plant, by cutting off and destroying the black knot early in July, its further propagation may be effectually stopped."

Now, according to all of our observations the seed of the fungus is not perfected in July and August, nor indeed until some months later. Externally, it is true, the fungus appears to have attained its full development, but if one of these little black globes—*perithecia* they are called by botanists—be taken from the tree at this time and crushed on the slide of the microscope, and its contents examined, little oblong, pale membranous sacs will be seen. They are not all equally developed, and are evidently rudimentary. If we again examine the contents of some of the perithecia, collected at a later period, say in November, we shall find that our rudimentary sacs have increased considerably in size. They are now cylindrical, and contain a greenish, grumous endochrome, from which the spores are destined to be formed. The earliest period in which we have found the spores developed is the middle of January. In specimens collected January 13th, spores were found in a few of the sacs, but most of them were yet filled with their greenish contents. We have found spores in specimens collected as late as June, therefore the time in which the fungus perfects its seed may be said to be from January to June. Thus it will be seen that the plant is not an annual, as some have affirmed, but one that requires from fourteen to twenty months from the time of its first manifestation as an incipient excrescence to the time of the maturity of its seed; and from eight to fourteen months from the time of its first external appearance as a plant to the perfection of its seed.

Having thus dwelt at some length on this subject, we will briefly notice one or two inferences, which we find in the articles of the *Practical Entomologist*, from which we have quoted. We would not even notice these did we not believe them erroneous and fraught with mischief. It is stated that "about the last of July or the first week in August, there grows from each fungus on the surface of the black knot a little cylindrical filament about one-eighth of an inch long, which no doubt bears the seed or spores, as they are technically termed, of the fungus, and that these filaments very shortly afterwards fall off and disappear, leaving behind them the hemispherical plates, which alone had been hitherto noticed by botanists. * * I discovered that the filaments not only cover the entire surface of the black knot itself, except where a few of them had fallen off, but that they were thinly studded over the twig for an inch or two above and below the swollen black part."

We do not pretend to say what these little cylindrical filaments were, not having seen them, but it is very evident, from the fact that they extended on the twig an inch or two above and below the swollen black part, that they had nothing whatever to do with the bearing of the spores of this fungus, for its spores, we have seen, are produced in little sacs within the so-called hemispherical plates, which do not extend beyond the swollen part, and besides, the spores are not mature until long after the assigned time of these filaments. Once only have we observed anything that seems to correspond somewhat with the description of them. In the latter part of August we collected specimens of black knot on the wild bird cherry, *Prunus pennsylvanica*, some of the perithecia of which had a little cylindrical rostrum or beak growing from the apex. But all these perithecia, when cut open, were found to be black inside and entirely barren, while those without the filament or beak even on the same excrescence were white inside, as in the normal condition, and contained rudimentary sacs. We have also frequently seen perithecia without the beak that were black inside. These were, in every instance, sterile.

We quote once more, this time in reference to the second inference. "But from the evidence which will be adduced below it appears to follow as a necessary consequence, that the black knot on the cherry is caused by a distinct species of fungus from that of the plum." Then the evidence is adduced, which consists in plum trees

sometimes being attacked while cherry trees in their vicinity escape, or the reverse. Then these words follow: "The practical inference to be drawn from the above theory is, that plum growers need not be alarmed when their neighbours' cherry trees are swarming with black knot, and cherry growers need not be alarmed when their neighbours' plum trees are infested in the same manner; for the disease can only spread from plum tree to plum tree, and from cherry tree to cherry tree. * * * It would further seem to follow that black knot, growing upon the wild choke cherry cannot spread upon our cultivated cherry, and still less upon our cultivated plum trees; but black knot undoubtedly can and does spread from the wild plum tree on to the tame plum tree, and probably from the wild red cherry on to our tame cherry trees."

We are not disposed to dispute the correctness of the observations from which this inference was drawn, but we do believe the inference to be incorrect, and calculated to lull fruit growers into a feeling of false security. We have carefully examined good fruiting specimens of the black knot fungus, taken from the choke cherry tree, *Prunus Virginiana*; the cultivated cherry tree, *Prunus Cerasus*; and the cultivated plum tree, *Prunus domestica*; and we are prepared to state that there is no essential difference between the black knots of these trees. The spores in all are essentially alike, and mature at the same time. There is a slight difference in the general external appearance of the black knots of the different trees; but this is all, and no good botanist would venture to consider such a difference to be alone of any specific value. We have time and again observed plum trees and cherry trees along the same fence and in the same enclosure alike infested by black knot. We have seen plum trees badly infested in localities where the wild plum tree does not occur at all. We, therefore, conclude that the black knots of both plum and cherry trees are produced by the same species of fungus, viz., *Sphæria morbosa*, Schw., and that it can and does spread from cherry to plum trees, and from plum to cherry trees, and therefore that there is no safety for some cherry trees in the vicinity of affected plum trees, nor for some plum trees in the vicinity of affected cherry trees. We admit that there are certain species, both of cherry and of plum trees, that do not seem to be liable to the attacks of this fungus, which perhaps is the origin of the theory of distinct species of black knot.

PROCEEDINGS.

June 14th, 1872.—Conversational Meeting.

The objects exhibited were—

Wenham's new Reflex Illuminator—Podura scale, dark ground	Mr. McIntire.
Muscular Fibre of Shrimp	Mr. Slade.
Living Embryo of Planorbis	Mr. J. Goodinge.
Heart of Living Tadpole Newt	Mr. Fitch.
Transparent Injection, Tongue of Hedgehog	Mr. Topping.
Spider's Nest	Mr. A. Waller.
Pond Life, &c.	Dr. Ramsbottom.
Various Marine Animals in Cells	Mr. Matthews.
Richards' new Protecting Cap	Mr. Richards.
Sawfly, *Tenthredo cincta*	Mr. Freeman.
Transparent Injection, Nose of White Mouse	Mr. Topping.

June 28th, 1872.—*Chairman*, Dr. R. Braithwaite, F.L.S., &c., Vice-President.

The following donations to the Club were announced:—

"The Monthly Microscopical Journal"... ...	from the Publisher.
"Science Gossip"	,,
"Proceedings of the Royal Society," No. 134 ...	the Society.
"Conspectus of the Diatomaceæ"	Prof. H. L. Smith.
"The American Naturalist" for May and June	in exchange.
"Fourteenth Report of the East Kent Natural History Society"	from the Society.
"Report on the Minute Anatomy of Cancer," accompanied by Micro-Photographs...	Lieut. Col. Woodward, U.S. army.
"Proceedings of the Geologists' Association"...	the Association.
Slack's "Pond Life"	Mr. J. W. Goodinge.
Cobbold's "Entozoa"	Mr. J. W. Groves.

The thanks of the Club were unanimously voted to the donors.

The Chairman announced that the first business of the meeting would be the nomination of gentlemen to fill the office of Vice-Presidents for the ensuing year. There were four Vice-Presidents to be elected, and any member of the Club was competent to propose a name in accordance with the bye-law No. 3, which was then read by the Secretary.

The following nominations were then made:—

Dr. Lionel S. Beale	Proposed by	Dr. Gray	Seconded by	Dr. Matthews.
Mr. Arthur E. Durham	,,	Mr. Hopkinson	,,	Mr. Allbon.
Mr. Henry Lee	,,	Mr. Curties	,,	Mr. Burr.
Dr. Matthews	,,	Mr. Oxley	,,	Dr. Foulerton.

The Chairman next invited nominations of gentlemen to fill four vacancies on the Committee, in place of Mr. Crook, Dr. Matthews, Mr. McIntire, and Mr. Lowne, the four senior members by election, who retired this year in accordance with the rules.

The following gentlemen were then nominated :—

Mr Ingpen	Proposed by	Mr. Curties	Seconded by	Mr. Pett.
Mr. B. D. Jackson	,,	Mr. Golding	,,	Mr. McIntire.
Dr. Ramsbottom	,,	Mr. McIntire	,,	Mr. Gay.
Mr. Oxley	,,	Mr. Marks	,,	Mr. Allbon.
Mr. Slade	,,	Mr. Burr	,,	Dr. Matthews.
Mr. Jas. Smith	,,	Mr. Hailes	,,	Mr. Jackson.
Mr. J. G. Waller	,,	Dr. Matthews	,,	Mr. Marks.

Seven gentlemen having thus been nominated for the four vacancies, the number was reduced to six, in accordance with the rule, and on taking a show of hands in favour of each, the Chairman declared Mr. Jas. Smith to be in the minority, and his name was accordingly struck out.

Mr. W. T. Suffolk having been appointed auditor on behalf of the Committee, Mr. Dobson was proposed by Mr. Gay, seconded by Mr. Oxley, and unanimously elected by the meeting as auditor on behalf of the members.

The Secretary announced that the committee had nominated for the offices of Treasurer, Hon. Secretary, and Hon. Secretary for Foreign Correspondence, the gentlemen who had respectively filled those offices during the past year.

Mr. Jas. Smith was then called upon to make a promised communication to the meeting, but not being prepared (owing to recent indisposition) to do so,

The Secretary introduced to the notice of the members an ingenious portable cabinet, sent for exhibition by Mr. W. K. Bridgman, constructed to hold the slides so as to prevent them from rattling whilst being carried in the pocket. The specimen exhibited was neatly made of wood, and held twelve slides—six on each half, the two halves folding upon each other by a hinge joint when closed, and being secured in that position by an india rubber band. A sliding plate of wood inserted in the outer edge of the frame securely held the slides in their places, and effectually prevented them from shaking, but enabled them to be readily taken out when it was withdrawn.

Dr. Foulerton read a paper descriptive of some new cells for infusoria, in which they might be kept alive for lengthened periods. Dipping tubes, recommended for use in filling the cells and isolating the minute creatures they were intended to contain, were also exhibited to the meeting, and drawings were made upon the black board in further illustration of the subject.

The Chairman, in proposing a vote of thanks to Dr. Foulerton for his interesting communication, expressed a hope that these very ingenious little cells would lead to more attention being paid to the infusoria.

The Secretary said that since Dr. Foulerton had introduced these cells to his notice he had used them, and found them most useful; he thought, too, that in them he had found a key to the question "How to utilize the Excursions?" When large quantities of infusoria were brought home there was always great trouble in ascertaining what species were found, and, if a strange form appeared, it could never be found again after it had been returned to the water; but these cells would enable anyone to get over this difficulty, as specimens could easily be isolated, and repeatedly examined, and could be brought to the meetings of the Club to be shown to those who did not go to the excursions. He had a short time

ago put a small quantity of green scum from a pond into one of these cells, and it was now filled with a beautiful growth of living diatoms and desmids.

Mr. Golding thought that the matter which had been brought before them was of great interest, since it would enable a person to preserve gatherings as long as possible, and to examine the same objects during an extended period of time, and by this means to make important observations upon the changes which took place during growth and development. It might be of interest to the members of the Club to know that it had been recently observed at Liverpool that some rotifers, found in a tank used for cooling the water from a steam engine, had attained an extraordinary degree of development, and were at least twice the size of similar species found in cold water elsewhere.

Mr. Reeves said that if Dr. Foulerton would undertake to do the naming and explaining, the Excursion Committee would be most happy to keep him employed by supplying material.

Dr. Foulerton expressed his willingness to do all in his power, and suggested that members should employ their time during the fortnight between the meetings in ascertaining what they had got, and in separating the objects, and should then bring them to the meetings for further examination.

Mr. Reeves thought the first difficulty always was to know what they had collected.

Dr. Foulerton imagined that it would be very easy to ascertain this by a simple lens, and having done it, the next thing was to separate the objects—it would at all events be interesting to do this, and if there was a large supply obtained it might be distributed to others.

Mr. Reeves said that this of course would rest with the individuals who went out; some brought home a carpet bag full, and they always had plenty to distribute; but the trouble was to know really what was collected. If Dr. Foulerton could name someone in each branch of study to whom specimens could be submitted for identification, and who would give instructions in their special departments, then, he thought, some good might be done.

The Secretary suggested that the idea held by Dr. Foulerton was that at an excursion probably some members might find Limnias, others might find Melicerta, and so forth, and that these should be separated from each other and then brought to the meetings for comparison and identification.

Mr. Reeves said there was hardly an excursion at which Limnias and Melicerta were not found—he did not see any difficulty with such well-known forms—but when large quantities of other species were taken, it was a matter of very great difficulty to discriminate between them.

Mr. Curties inclined to a belief that the question was to a great extent one of distribution. He had often wondered how it was that the excursions produced so little fruit; and it would seem that gentlemen who were able to go out on Saturday afternoons gathered large quantities of materials, but because Mr. Reeves failed to discriminate, the Club failed to hear and know what was done. If those who went would oblige others who could not go with bottles containing a portion of their gatherings, he had no doubt but that the results of the excursions would be found more satisfactory.

Mr. Reeves expressed his opinion that very few persons would be found to go out if others would collect for them.

Mr. Curties said this of course was only the natural order of things.

The Chairman thought that what they really wanted was some worker in each department competent to distinguish what had been collected during the excur-

sions. All would probably know Melicerta when found, but there were a great many minute infusoria which they might never have seen before and have no opportunity of becoming acquainted with, from want of time or other causes; so that not being able to name them, and not knowing who to apply to to get them named, a large quantity of what was collected was thrown away and wasted. If those gentlemen who possessed the requisite knowledge in the different departments would give in their names as being willing to assist in the matter, very much more use might be made of the material collected. He would just mention that the Birmingham Society was divided into sections, each having its own President and Committee, and each section met once a week. In this way much more was accomplished, and a great many more results were attained than it had been yet possible for the Club to achieve.

Mr. Reeves said that he would undertake to supply materials to any one who engaged in any special study.

Mr. Hind inquired whether it had ever occurred to anyone that the excursions being fixed for 2 o'clock might prevent many persons from joining in them?

Mr Johnson said that as a matter of fact some members generally did start after the time named, and could be certain to find the others by a few local inquiries.

Mr. Bird brought for exhibition to the meeting a curious monstrosity of a cabbage.

Dr. Foulerton said that he omitted to mention that the wood of which his cells were composed ought to be varnished, and cork should be treated in the same way to prevent the escape of small infusoria through crevices and pores.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Various Diatoms, &c.	by Mr. Cole.
Stellate Hairs arranged in various forms (polarised)	Mr. Curties.
Rose Chafer (*Cetonia aurata*)	Mr. Golding.
Under Surface of Leaf of *Rhododendron Callophylla*	Mr. Jackson.
Parasite of Damson Tree	Mr. Pett.
Scale of Podura, shown by $\frac{1}{80}$in. Object Glass ..	Mr. T. Powell.
Two-Winged Day Fly and Larva of Dermestes ...	Mr. Geo. Williams.
A Cabbage (monstrosity)	Mr. Bird.

Attendance—Members, 66; Visitors, 5.

July 12th, 1872.—Conversational Meeting.

Objects exhibited—

Coccuss of Pine Apple...	Mr. Oxley.
Scale of Carp (polarised)	Mr. Gibson.
Cristatella mucedo	Mr. Golding.
Œcidium Euphorbiæ and two others	Mr. Freeman.
Daphnia pulex, &c.	Dr. Foulerton.
Bichromate Potash (polarised)	Mr. T. C. White.
Growing Desmids	Mr. T. C. White.
Hippuric Acid	Mr. T. C. White.
Stemonitis ovata	Mr. Oxley.

Series of Campylodisci...	Mr. Hailes.
Ancyllus orovatus (?) ... ... Ova of Snail	Dr. Ramsbottom.
Transverse Section of Bamboo	Mr. Sigsworth.
Compound Spot Lens for dark ground, with $\frac{1}{8}$th object...	Mr. Burch.
Crystals of Uric Acid, crystalized on a nucleus of blood-colouring matter	Dr. Matthews.

ANNUAL MEETING,

JULY 26th, 1872.—*Chairman*, DR. LIONEL S. BEALE, F.R.S., &c., President.

The Secretary read the Annual Report of the Committee, also the Treasurer's Report, and Balance Sheet, duly audited.

The President moved a resolution, "That the Reports now read be received and adopted."

Dr. R. Braithwaite seconded the motion, which was then put to the meeting und carried unanimously.

Dr. Matthews, after reference to the fact that no item appeared in the Balance Sheet as having been paid for rent, paid a high tribute to the generosity of the authorities of University College in permitting the Club to meet in that building free of all expense, and moved a resolution, "That a cordial vote of thanks be presented to the Council of University College for the many acts of favour accorded to the Club, and especially for the privilege of meeting free of charge in the Library of that Institution."

Dr. Braithwaite seconded this motion, which was unanimously carried.

The Ballot then took place for the election of gentlemen to fill the vacant offices during the ensuing year, nominations for which were made at the previous ordinary meeting. Mr.W. W. Reeves and Mr. Ward were appointed to act as scrutineers.

The President then read his annual address, which was listened to with the greatest attention and warmly applauded.

The scrutineers having handed in the result of the ballot—

The President announced that the following gentlemen had been duly elected:—

As President ...	Dr. R. Braithwaite.
As Vice Presidents ...	Dr. Lionel S. Beale. Mr. Arthur E. Durham. Mr. Henry Lee. Dr. John Matthews.
As Members of Committee ...	Mr. John Ingpen. Mr. B. D. Jackson. Mr. F. Oxley. Dr. Ramsbotham.
As Treasurer ...	Mr. R. Hardwicke.
As Hon. Secretary ...	Mr. T. C. White.
As Hon. Secretary for Foreign Correspondence	Mr. M. C. Cooke.

The President then left the chair and formally installed Dr. Braithwaite as his successor.

Dr. Braithwaite cordially thanked the members of the Club for the honour they had conferred upon him in electing him as their President, and for the honour done not only to himself but to the profession to which he belonged, and which had furnished each president since the Club had been in existence. So far as he was able he should be happy to render his services to the Club, but it would be to the working members of it that he must look for that efficient support which they only could render, and upon which alone success must depend.

Mr. B. D. Jackson had much pleasure in moving "That a vote of thanks be presented to the President and Officers of the Club for their valuable services during the past year."

Mr. Sigsworth seconded the proposal, which was put to the meeting and carried by acclamation.

Mr. T. Curties said that in addition to the resolution which had just been put to the meeting, he should like to propose "That a special vote of thanks be presented to Dr Lionel S. Beale for his valued aid and great kindness to the Club during the period of his presidency, and also for his very valuable address just read, which it was hoped they would be allowed to publish *in extenso* in their Transactions."

Mr. Pett had great pleasure in seconding this motion, which was put to the meeting and carried unanimously, amidst great applause.

Dr. Beale expressed his thanks to the meeting for the vote of thanks to himself which they had so enthusiastically passed, and only wished that he had deserved it more; for he felt conscious that of late he had not been amongst them so often as he could have desired. He should look back upon the past two years with great pleasure, and he could certainly say that some of the pleasantest evenings he had ever spent had been spent with them in that room. The meetings had brought back to his mind much of the work which he used to engage in, and which he only regretted that his present engagements did not now permit him to follow more closely.

Mr. J. G. Waller proposed a vote of thanks to Mr. Reeves and Mr. Ward for their services as scrutineers that evening.

Mr. Burch seconded the proposition, which was unanimously carried.

The Secretary announced the following Donations to the Club:—

"The Monthly Microscopical Journal" ...	...from the Publisher.
"Science Gossip"	,,
"The Popular Science Review"	,,
"Proceedings of the Royal Society," No. 135,...	the Society.
"The American Naturalist"	...in exchange.
The first No. of "Grevillea,"	.. from the Editor.
"Proceedings of the Geologists' Association" for July	the Association.
Perira's "Lectures on Polarised Light," ...	Mr. T. C. White.
Taylor's "Half Hours at the Sea Side," ...	Mr. Pett.
12 Slides of Injected Preparations	Mr. Amos Topping.

The thanks of the Club were voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. John Alstone, Mr. Thos. Wm. Cowan, Mr. Ernest Doggett, Mr. Thos. Harper Francis, Mr. John Harrod, Mr. Charles N. Levien, Mr. George

Nicoll, jun., Mr. J. Sargent, jun., Mr. J. Sarl, and Mr. J. S. Townsend, F.R.M.S. ; and Doctor S. O. Lindberg, of Helsingfors, Professor Hamilton, L. Smith, of Hobart College, Geneva, U. S. A. ; and Dr. J. J. Woodward, Assistant Surgeon General United States Army, were balloted for and elected Honorary Foreign Members of the Club.

The Secretary read a paper descriptive of a new elementary hand microscope, sent by Dr. Guy for exhibition to the members.

The President moved a vote of thanks to Dr. Guy for his communication, and expressed his admiration of the microscope which had been lent for their inspection, and which he thought was the most beautiful instrument of its class which had yet been brought out.

The Secretary called the attention of the members to the communication received from Mr. T. W. Wonfor, inviting the co-operation of members of the Club at a soirée, to be held at Brighton during the meeting of the British Association, and intimating that the L. B. and S. C. Railway had offered to extend the privileges granted to the members of the Association to any members of the Club who might desire to be present on that occasion.

Mr. McIntire inquired what was to be exhibited, as he believed there was some plan laid down with respect to the objects.

The Secretary said the objects exhibited were to be illustrative of marine life.

Mr. Curties informed the members that the Society at Brighton had promised to supply objects for exhibition to any of the members who would attend and take their microscopes.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Microscopic Fungi	by Mr. Burch.
Eolis (a nudibranchiate Mollusc) alive	Mr. Oxley.
Proboscis of *Syrphus ribesi*	Mr. Sigsworth.
Œcistes crystallinus (group)	Mr. Geo. Williams.
Two Object Glasses of American manufacture by Wales, $\frac{1}{6}$ and $\frac{1}{15}$ in., brought for exhibition and comparison	Mr. Ward, of the Bailey Microscopical Society.
Spicules of Gorgonia, various	By Mr. James How, in Dr. Guy's Illuminator Hand Microscope.
Do. do. white	
Crystalised Silver	
Elytron of Diamond Beetle	

Attendance—members, 62 ; visitors, 8.

August 9th, 1872.—Conversational Meeting.

Objects exhibited :—

Aulacodiscus formosus	Mr. Sigsworth.
Section of India Rubber / Crystals (?) of Gutta Percha } polar	Mr. Burch.
Living Larva (unknown) shewing internal organs ...	Mr. Fitch.
Teeth of Medicinal Leech	Mr. Topping.
Sections of Teeth showing secondary dentine and exostosis (polarised)	Mr. T. C. White.
Badhamia utricularis...	Mr. Oxley.
Brazilian and Oriental Opals...	Mr. Hailes.
Diatomaceæ	Mr. Williams.
Tracheal System of Ephemera Larva	Mr. J. A. Smith.
Tongue and Lancets of Gad-fly	Mr. Daintrey.

Attendance—Members, 33 ; Visitors, 4.

August 23rd, 1872.—*Chairman*—Charles F. White, Esq., F.R.M.S.

The following donations to the Club were announced :—

"The Monthly Microscopical Journal" ... from the Publisher.
"Science Gossip" ... ... ,,
"The Lens" ... ... in exchange.

And the thanks of the Club were voted to the donors.

The following gentlemen were balloted for, and duly elected members of the Club :- Mr. Arthur Goode, Mr. B. Hembry, Mr. William Stuart Smith, and Mr. Thomas Terry.

There being no Paper, or topic, for discussion, the Chairman invited observations from gentlemen descriptive of objects exhibited in the room. No response, however, was made, and the proceedings were brought to a close by the usual announcement of meetings for the ensuing month, and a conversazione, at which

The following objects were exhibited :—

Lacinularia socialis	by Mr. Birch.
Injections of Human Anatomy	Mr. Arthur E. Durham.
Flower of Mignonette	Mr Goodinge.
Eyes of *Epeira Diadema*	Mr. Martinelli.
Arachnoidiscus Ehrenbergii	Mr. Nelson.
Arenaceous Foraminifera	Mr. Slade.
Trichina spiralis	Mr. Topping.
Plumatella repens	Mr. Geo. Williams.

Attendance—Members, 33 ; Visitors, 8.

R. T. Lewis.

Description of an Instrument proposed as a Standard Dynamometer, for determining the Magnifying Powers of Microscope Objectives.

By John E. Ingpen, F.R.M.S.

(*Read Sept. 27th*, 1872.)

This instrument has been contrived in accordance with the views expressed by Dr. Ward, in a paper " On Uniformity of Nomenclature in regard to Microscopical Objectives and Oculars," in " The American Natural," and reprinted in " The Monthly Microscopical Journal" of July 1, 1872, p. 15, to which reference should be made. It consists essentially of two scales, ruled on glass, one of which is magnified by the objective, the other not. The ratio of equal spaces on the two scales gives the magnifying power of the objective, at the distance between the scales.

Description.—A tube (plate v. fig. i.) A carries at one end a glass scale micrometer seen edgeways at B, and also a positive eyepiece, C; and at the other end a tube D, carrying the glass scale micrometer E, which is capable of being focussed on the objective by the milled head F. Inside the tube A, slides another tube G, into which H, the objective to be tested, is screwed. By means of the milled head K, the front surface of the objective H can be set at exactly ten inches from the scale B. To measure this distance, D is temporarily removed, and a cap L, substituted, which cap is of such a length as to place the front surface of the objective at the required distance when flush with the aperture M, or touching a rule laid across it. The cap L is then removed, and D slid on to A, when the scale E can be adjusted to the focus of the objective, and the comparison between the two scales made. The distance of ten inches from the front of the objective to the scale B has been selected instead of a *fixed* distance between the two micrometers, for the reason that the objectives are thereby put more nearly under their usual working conditions; if the distance between the scales

be fixed, low powers are registered as magnifying less than they do in practice. The number of divisions on the scale B corresponding to one or more on the scale E, gives at once the power of the objective. Thus, if ten divisions on B cover one on E, the power of the objective is *ten diameters*, and should be registered × 10.

With objectives having adjustment for thickness of covering glass, and those with wet and dry fronts, two or more measures may be taken. One of the micrometers supplied is *uncovered*, and can have glass covers of known thickness laid on it: thus, the power of an objective can be found at "uncovered," at "covered" for a known thickness of glass, or at "covered" with a known position of the divisions on the screw collar, or with a wet front under any of these conditions, thus affording a complete registration of the power of the objective.

The instrument is constructed so as to be complete in itself; the rack at F being sufficiently delicate for focussing the scale E, with due care, even on the highest power objectives, but it would be better for the tube A to be attached to a firm microscope stand, with a good slow motion. The tube D can then be dispensed with, and the scale E taken out and viewed, as an ordinary object, on the stage of the microscope.

There is no difficulty in reproducing such an instrument as this, bearing in mind the *one* point essential to it as a *standard*, viz., that the front of the objective must be exactly *ten* inches from the upper or eyepiece micrometer. The value of the scales, whether French or English, &c., is of no consequence, provided they are equal or one a known aliquot of the other. The scales should be carefully tested, by reversing their positions or other means, as, of course, much depends upon their accuracy.

The distance of ten inches has been selected, as about that most usual in England. It seems that in America *longer*, and in France and Germany, *shorter*, bodies are preferred. The distance of 250 millimetres ($9\frac{5}{6}$ inches) has been suggested, which would not make much difference, but it would probably be best to leave the *Quekett standard* at ten inches, and not to alter it without good cause.

It is hoped that this *standard* will render unnecessary many of the calculations which are so troublesome and unsatisfactory, such as attempting to find focal centres of compound systems, comparison with a one-inch lens (which would be probably only correct for parallel rays), &c., &c., while the mode of operation is, it is

hoped, comparable in accuracy with that of throwing the image of the scale upon a screen, and is far easier of performance.

Our best thanks are due to Mr. Curties, who has taken much trouble, and made some valuable suggestions, in constructing the instrument. If it prove useful to the members of the Quekett Club, it will amply fulfil its purpose.

Pneumatic Injecting Apparatus for Microscopical Purposes.

By T. Johnston English, St. George's Hospital.

(*Read October 25th*, 1872.)

The process of injecting for microscopical purposes is an operation which requires much skill and practice, and in order to obtain really good results, much time and patience must be expended on it. It is with a view to lessening its difficulties that I wish to bring under your notice, to-night, this simple apparatus, the description of which I will at once enter upon.

The instrument consists of a Woulfe's bottle, having three necks (pl. v. fig. ii, Nos. 1, 2, 3). No. 1 neck is fitted with a cork, through which passes a piece of bent glass tube, of the diameter of a goose-quill, one end of which reaches to the bottom of the bottle, and to the other is tied about 12 inches of india-rubber piping of the same diameter; the glass tube is made perfectly air tight in the neck of the bottle by sealing wax varnish, and the india-rubber one is closed by a pinch-cock.

In No. 2 neck is a contrivance which answers the purpose of a condensing syringe; it is made of a piece of glass tubing 5in. or 6in. in length (fig. ii. A), passing through a cork, and also rendered air tight by varnish; to the upper end is tied an india-rubber ball (B), having a small hole on one side (C); the lower end is closed by a valve (D), opening downwards. This valve is made in the following way:—A piece of gutta-percha is placed in boiling water, and when perfectly soft and pliable, it is forced into the end of the glass tube (see fig. iii.), so as to form a plug (E), extending upwards for about $\frac{1}{2}$in. It is then allowed to cool, and when hard, it is trimmed with a pen knife. A small hole is then bored through

its centre, and over it is fastened, by means of heat, a small, thin, flat piece of ivory, made from a vaccine point, a little longer than broad (G in figs. iii. and iv.), also having a hole in its centre; this piece of ivory forms the basis or rest for the oil silk valve (H in figs. iii. and iv.) which is of the same shape, but a little smaller, and is retained in its place by sealing-wax varnish at one margin only. A coating of varnish is then carried over the gutta-percha and lower part of the glass tube, to stop all escape of air at the junction of the two, care being taken to keep the ivory plate free from it.

The 3rd neck is closed by a cork, packed with wash leather, and serves for the introduction of the injecting fluid into the bottle.

To use the instrument the requisite sized nozzle is fixed on the gutta-percha tube, which is closed by the pinch-cock; about 4oz. of injection are then poured into the bottle through the third neck, and the cork firmly inserted, the leather surrounding it having been previously wetted; pressure is now made on the ball B, taking care to place one finger over the hole C, by this means the air is forced down the tube through the valve into the bottle; on removing the pressure from the ball the valve closes, and the ball is refilled by air entering the small hole C; after this operation has been done twice the pinch-cock of No. 1 tube is cautiously opened, and the injecting fluid, acted on by the condensed air in the bottle, rushes up that tube; when it completely fills the tube and nozzle, the cock is again closed, and further exit of the fluid restrained. The instrument is now ready, and the nozzle is introduced and tied into an artery in the same way as the ordinary syringe.

I have used glass for the nozzles, preferring that material to metal, not only because they are lighter, but because they can be made very easily, and can be drawn out to the finest size. When the injection requires replenishing, the cock is closed and more fluid poured in at the third neck.

Such is the instrument in its simplest form, but, if wished, it may have a small manometer attached to it, to indicate the exact pressure employed, although I have generally found that the amount of force required to drive the air out of the ball into the bottle is a sufficient guide. The bottle may be of any capacity, and in choosing one, regard should be had to its strength and freedom from cracks and flaws of any kind; and when completed, it should be tried with a little water, high pressure being used, to test its capa-

bilities of holding condensed air, so that should it be faulty and break, it will do so then in all probability; but I do not think that such a result would occur with ordinary care, as the vessels of the animal which is being injected burst if much force be used.

It is not my intention to enter into the respective merits of the bottle and the syringe, but there are two advantages which the former possesses over the latter. The first is that it leaves *both* hands entirely free during its action, and the second is its cheapness, the whole instrument costing when finished about 4s.

An Omission Corrected.

We regret an omission in our last issue, which occurred inadvertently, no report having been furnished to us. It was to notice the new pattern $\frac{1}{40}$th immersion lens, by Schieck, of Berlin, which attracted so much attention at our meeting held on the 28th of June last. We may here mention that it was greatly admired for its remarkable abundance of light, perfect flatness of field, and brilliancy of definition.

The objects used with it were (1) *Surirella Gemma*, the longitudinal and transverse lines of which it shewed with the utmost distinctness; (2) *Navicula Cuspidata*, the lines on which were beautifully resolved into "dots." Some, on the other hand, objected to the presence of colour—a faint ruby tint—which seemed to be associated with its best performances. This, however, is characteristic of almost all German lenses, and is owing to the preponderance generally given by the German opticians in their immersion combinations to the crown glass over the flint glass. Mr. Schieck, we believe, was, till within the last two years, a pupil of the celebrated Dr. E. Hartnack.

Histo-chemical Researches on the Fall of Leaves in Autumn.

By Dr. K. Ledeganck.

Translated, and abridged, by B. D. Jackson, F.L.S., F.R.M.S., from the "Bulletin de la Societé Royale de Botanique de Belgique," tom x. No. 3. 3rd June, 1872.

(*Read November 22nd*, 1872.)

1.—*Historical.*

A fact worth remarking in the history of the sciences dependent upon observation, is the reluctance with which the experimental method is introduced, and the cautious use the first workers have made of it, to resolve the problems relative to the vital functions of plants and animals.

This statement receives a full and entire confirmation in the history of the subject before us. The fall of the leaf in autumn, a phenomenon which strikes even the unobservant by its regular occurrence, and by the remarkable change produced by it each year in the face of nature, is still one of those questions hardly glanced at by a large number of writers, who usually pass it over in silence, or to explain which, they have been satisfied, for a long period, to offer hypotheses as diverse, as they are unsafe.

It is true that we are no longer in the same plight as when Ingenhousz (1779) explained the phenomenon in question by a final cause, having for an object the preservation of the human race, thus:—"When the cold of winter stops the universal tendency to decay, we have no need of the assistance of leaves to purify the atmosphere, which is no longer infected. The leaves falling, and the tree continuing to live without them, tells us that they have more to do with our conservation than that of the tree."

Mustel believed it was purely mechanical, and in the domain of hydro-dynamics. The transpiration by leaves being suspended in autumn, the ascending sap accumulates in the leaf, petiole, and axis. From this results a strong interior pressure, which has the effect

of detaching the leaf from the bough which bears it. Murray also attributed the cause to a mechanical one, but although entirely opposed to Mustel, his interpretation is not less problematical. The latter maintained that the sap, far from distending the leaf, is on the contrary stopped in its upward course by the axillary bud : this bud, compressing the tissue at the base of the petiole, at first hinders the sap from getting to the leaf, and afterwards continuing to develope, presses down the leaf, already suffering from loss of nourishment, and causes first a rupture in the tissues, and lastly the fall of the organ.

Sénébier thoroughly adopted these ideas of Murray (1798), and defended them with ability. He set himself to combat the many objections which arose against the theory, but the reasons which seemed so strong to him, are not borne out by careful observation of facts.

It is in the writings of Duhamel and Vrolik bearing on the subject, that we have found the first accurate observations, based upon an attentive study of the tissues, and the modification they undergo in autumn ; the explanation only, is erroneous. Thus, Duhamel described between the stem and the base of the leaf, a layer of cellular tissue, which is disorganized by the influence of cold ; in addition, he thought that the leaf stopping in development whilst the stalk continued to grow, a tension resulted which ended in the separation of the two. This cellular tissue of Duhamel really exists, but, as we shall see, it forms part of the *pulvinus*, somewhat elastic, always fixed to the stem, serving to unite leaf and stem, and the elasticity of which, to some extent, protects the leaf from being prematurely torn away from the stem. The effect of cold in separating the two is also undoubted, but its mode of action is quite different from what Duhamel supposed.

Vrolik (1796) saw in the separation of the leaf an effect of resorption. The resorbed tissue leaves a gap, which is the starting point of the solution of continuity. This resorption is, nevertheless, a fact, although exceptional, but our author has generalised too much from it. Farther on we shall see in what cases it may be observed ; anyhow, it appears certain that in many cases Vrolik has mistaken a solution of continuity, which was no more than the beginning of a mechanical separation between the leaf and its support, for an effect of resorption.

Link, begins the series of phytotomical observers of the modern school, which attaches itself above all, to close observation of facts. According to this clever observer, the cause of the fall is inherent in the leaf-structure, and pre-exists in every chemical and mechanical alteration of the tissue. At the point of union of the petiole with the pulvinus, a layer of cells, placed in a different direction to those of neighbouring layers, determines the weak point, where, later on, separation must take place. As to the proximate cause of the separation, our author states nothing positively.

Mettenius, in the course of his researches on the ferns, is led to admit of the formation of a new tissue, a thing difficult to imagine occurring in an organ in the decline of its vitality, such as a leaf ready to fall. This tissue, "delicate parenchyma," is produced between the base of the petiole and the pulvinus, but dying soon after, it occasions the disarticulation of the parts it formerly united. The imposing authority of Hugo v. Mohl is brought in to support these observations, which, nevertheless, seem to us insufficiently established, and which, for our part, setting aside the ferns, we have never been able to confirm by microscopical research. Still, if the existence of this special "separating layer," the cells of which have the faculty of speedy self disorganization, were proved for all articulate leaves, what would happen to the vascular bundles? If these latter remain intact, as Hugo v. Mohl admits, to be afterwards broken mechanically, how could the separation of the leaf happen so completely and suddenly, leaving so clean a scar for all leaves alike? Besides, the production of this young tissue in the midst of other tissue in process of drying up, appears to us difficult, if not impossible to admit, and that it is not established by direct observation.

To Schacht (1852) is due the merit of having, by his observations upon *Dracæna reflexa*, placed the first indicator in the path so vaguely traced out before his time. It was whilst reading his remarkable work, *Die Pflanzenzelle*, that we were induced to commence our work; and it is to reply to the appeal which he there makes to botanical micrographers, which induced us to undertake a long series of investigations on this interesting and debated subject. We may, perhaps, be permitted to cite here the words of the passage:—

"This fact, certain as to *Dracæna reflexa*, may probably throw light upon the fall of the leaf generally. The leaf, as we know,

grows by its base; there, is formed the growing tissue, but this tissue can also give place to a corky production, for upon the leaves of most of our trees we notice a demarcation, easily seen by the naked eye, 'the articulation,' which points out the part where the leaf will separate from the stem at its fall.

"As far as I have been able to observe, myself, we find on the stem all the cicatrices covered with a layer of cork, which leaves nothing free save the woody cells of the vascular bundles. Schleiden had already pointed out the fall of the leaf as the result of the stoppage of the passage of liquids. I thought I had found in the suberification of the base of the leaf of *Dracæna* the cause of that interruption of osmose; and I wish to draw the attention of observers to an act so important in the life of the plant." (*Der Tod der Pflanzenzelle*, c. xii., p. 245.)

These ideas formed the point of departure in our researches; the results which we shall unfold farther on will tend to show how far Schacht's opinion may be admitted, and what are the physical and chemical influences which must intervene, before we can arrive at a solution applicable to the whole of the facts observed.

II.—Means of Observation.

Since the early part of the autumn of 1868, our micrographical studies have been entirely directed to the solution of this question, resumed the following year, and suspended for certain kinds of difficult observations during the autumn of last year (1871); our observations bearing upon the majority of the trees and shrubs of our climate.

It was upon the bushes in our thickets and the taller trees of our woods and public walks that we began our work; in these we have been able to follow the phenomenon step by step, by making different sections of the leaves of the same species, and submitting them to those re-agents which can throw light on the nature and successive modifications of the component tissues.

In the histological examination of the petiole, a transverse section is enough to give a clear idea of the relative disposition of the tissues. As for the pulvinus, recourse is almost always had to a longitudinal section, perpendicular to the *cicatrix*, in order to recognize the tissue which covers the latter. A cross-section of

the bough will give information as to the modification of the peridermal tissue.

The re-agents most generally used are:—

1.—Tincture of iodine and sulphuric acid for the detection of cellulose, by the fine blue colour which they give it.

2.—Schulz' test for the same purpose.

3.—Solution of copper in ammonia, which dissolves cellulose, and separates corky, cuticular, and woody tissues.

4.—Aqueous solution of iodine, which discloses the presence of starch in the cells, and gives a brown colour to suberous, peridermic and cuticular tissues.

5.—Alcohol and ether, to dissolve fats and resinous substances.

The following is a short account of our mode of procedure with each species:—

We examine in succession the leaves from a green bough, those from a withering one (from which they have begun to fall); and lastly, the scar left upon the stem after the fall of the leaf. Both the green and yellow leaf are examined in the state of articulation, with the pulvinus, by longitudinal sections, either radial or tangential across the pulvinus and the base of the petiole. We notice accurately the state of these parts in a fresh state, before proceeding to make use of any test. Transverse sections of the petiole and stem, when thought necessary, give a true idea of the disposition of parts about the articulation. Finally, the use of reagents discovers the existence of such and such tissues, according to the time at which examination is made. The brittleness of the articulation in autumn, of leaves about to fall especially, sometimes offers insuperable difficulties. In such case, the contiguous surfaces must be examined separately, as soon after separation as possible.

III.—General Considerations.

In its normal state, the insertion of the leaf upon its stem is either by *articulation* or by *continuity*. In the first case, a special organ, the *pulvinus*, acts as an intermediate organ between the stem and the leaf; in the second, a simple, annular constriction at the base of the petiole points out the anatomical point where the leaf begins. The pulvinus, a little lateral swelling of the stem, presents the same anatomical elements as the cortical part, only disposed in a slightly different manner; the medullary tissue of the stalk, in-

stead of forming the axis of the pulvinus, passes inside, and directs itself towards the apex of the axillary bud. Thus the pulvinus presents:—1st. The epiderm, either in a continuous layer or in strips, in the form of epidermal scales. 2nd. One or more coats of suberous or corky tissue, which form the periderm, the growth of which causes the destruction of the epiderm. 3rd. The cellular layer, the cells of which are filled with liquids, and generally provided with chlorophyll (herbaceous tissue of Duhamel). Two or three rows of cells on the outside are often filled with a red colouring matter. 4th. The central parenchyma equally full of juices, and which gives place to, 5th. Liber cells and vascular bundles, which run into the leaf.

The base of the petiole, which adapts itself to the surface of the pulvinus, presents much simpler organization. On proceeding from without to within we find—1st, Epiderm, like that on the surface of the leaf, with lengthened cells, like the ribs; it remains intact during the existence of the leaf, and corresponds to the epidermis of the pulvinus. 2nd, Parenchyma, or prolongation of the mesophyll of the leaf. This is much more abundant, looser, and more porous (lacuneux) on the outside of the petiole (inferior surface of the leaf) than on the interior (superior surfaces). It corresponds to these tissues. Periderm red and green cellular, and central parenchyma of the pulvinus. As a whole the parenchyma of the leaf stalk shows much larger cells, and oftener filled with air, than the corresponding portion of the stem. 3rd, Vascular bundles passing the parenchyma, and crowded the more, the closer we examine the base of the petiole.

In this comparative study of the structure of the petiole and pulvinus, three essential facts are brought out. 1st.—That the suberous layers (periderm)of the pulvinus are not continued into the leaf stalk, and stop when level with the imaginary line of articulation. 2nd.—The cellular tissue, with chlorophyll, stops also at the same level, and altogether the tissues of the pulvinus, which correspond to the mesophyll of the petiole, are distinguishable from the last, both by their texture and by the character of their contents. 3rd.—The vascular bundles are the only anatomical characters common to the two organs, and which pass from one to the other with perfect continuity.

We may add that the continuity of these two epidermides is quickly destroyed by course of development of the peridermal

layers, which cause the peeling off of the epidermis of the stem.

The detailed examination from direct observation, the micro-chemical studies which we have been enabled to make, and the consequent deeper insight into the nature of these different tissues, their changes in autumn, are what we have to offer for your consideration.

*IV.—Histo-Chemical Researches.**

Dr. Ledeganck then gives, at considerable length, his researches on the following subjects, which, although of great interest, are too long for insertion here :—

Obs. 1.	Betula alba, and Fagus sylvatica.	
2.	Ulmus campestris.	
3.	do.	14 Oct.
4.	do.	26 Oct.
5.	Ribes grossularia	13 Oct.
6.	Syringa vulgaris	25 Oct.
7.	do.	28 Oct.
8.	Tilia europæa	14 Oct.
9.	Populus alba.	
10.	Betula alba	20 Oct.
11.	Fraxinus Ornus	23 Oct.
12.	Juglans regia	24 Oct.
13.	Quercus Robur	20 Oct.
14.	Carpinus Betulus.	

V.—Special Observations.

There is one thing which above all needs explanation, that is the mode by which the rupture of the central vascular bundle is produced; whether the periderm is in form of layers or scattered cells, we have never seen the process of suberification break through the tissues constituting the vascular bundle of the axis. Sometimes it may be seen above the level of the scar, at other times below, but in most cases it will be found broken at the surface. Besides, in most cases, where the leaf separates spontaneously, we see the periderm form an uninterrupted layer upon the cicatrix,

**Author's Note.*—Not being able to relate *in extenso* the whole of our observations which bear upon a great number of species, we limit ourselves to extracts of which the results appear to us the clearest and most conclusive.

in which it is impossible to distinguish the ducts. Future observations may teach us how this is achieved.

In all the species which possess compound leaves, we have seen the leaflets undergo, at *their* points of articulation, the same course of modifications as the main stem, or rachis itself. With some, suberification begins with the leaflets, in others, with the common petiole. The leaflets of *Fraxinus Ornus* present the same appearance as their rachis, by depositing similar cork layers.

A very general occurrence, but of which we do not know the full significance, is the abundance of crystalline aggregations, in the *tissues of the leaf*, at the time of its fall, and however abundant this may be in the neighbourhood of the articulation, we have not hitherto been able to ascertain what part this phenomenon bears in the work of separation of the leaf from its support.

* * * *

VI.—Theory of the Fall of the Leaf.

As the foregoing observations show,* it is the growth of the peridermal layers which constitute the predisposing cause of the fall of the leaves. This corky substance, however it may be deposited, causes the death of the tissues which it shuts off, by depriving them of the flow of nutrient matter. In fact, "suberous tissue has only a short existence like living tissue. Its cells, when once they are completely formed *(suberifiées)*, only contain air; and in this manner stop the passage of liquids" *(Schacht)*. Its part *(rôle)*, is therefore to be at once destroyer and preserver; for being that tissue above all others fitted to cover the scar, it hinders evaporation in the denuded parts, and the spread of lesion in the parenchyma. On this basis it is easy to comprehend how the epiderm of the branches is destroyed when the peridermal layers are formed: also, that, that these layers, enlarging their extent, and extending from the outside of the pulvinus towards the centre of the articulation *(interligne articulaire)*, the passage of the plant juices, from the stem towards the leaf, will become more and more obstructed, the more this layer increases in thickness and extent; and it will be seen that the final result of this new formation, is the isolation of the parenchyma of the leaf from that of the pulvinus. Because, take what plant you like, woody, herba-

* This refers chiefly to the remarks on individual species, which have been omitted on account of their length.—Tr.

ceous, or subfrutescent (our observations extending to about 100 species), if the cicatrix be carefully examined, you will find it constantly made up of one or more rows of peridermal cells, in complete continuity with those of the stem. If, sometimes, it is difficult to show the existence of such tissue in course of formation, on the scar at least, its demonstration offers no difficulty, and the accordance of all our observations on this point give it an indisputable value; there may be doubt as to the *mode* of transformation, there can be none as to the result.

According to our notes, the peridermal tissue appears in the line of demarcation; either by the gradual transformation of the exterior layers, following a centripetal course, and leaving the vascular bundles only intact, this being what we term *layer suberification;* or else, by the transformation of the cell wall of certain pre-existing cells, or by deposit of suberous matter in their interior, an alteration which we term *diffuse* suberification (or suberification by *infiltration*).

The first case prevails in leaves distinctly articulated, such as the Elm, Lime, and Hazel. The second may be seen in plants having non-articulate or incompletely articulate leaves—for instance the Oak and Hornbeam, which may frequently be seen with leaves attached during the whole winter, till in the following spring they are thrown off; it is rather by a rupture of the tissues than by true disarticulation. Those leaves having incomplete articulation are distinguished from those possessing the complete process, by the very gradual manner in which the transition takes place between the pulvinus and petiole. In these the green cellulose is not abruptly interrupted at the level of the exterior constriction; there cannot be seen any central parenchyma, thick and juicy, in close contact *(adossé directement)* with a loose and air-containing tissue. The transition is gradual, and rises to a certain height in the petiole. In autumn no distinct layer betrays the position of the constriction, but the use of tests, points out a deposit of corky matter in many places in the central parenchyma and mesophyllum. These are, at first, scattered groups of from two to four contiguous cells, and may be clearly distinguished from the neighbouring ones. Later on these groups increase in size, and number, and appear most numerous in the proximity of the constriction, especially in that part answering to the pulvinus.

From the time when these altered cells attain a certain limit

all flow of sap is stopped, and the leaf, without dropping off, dies from dessication. Such is the mode of formation of this new tissue, the presence of which should be considered as the predisposing cause of the fall of the leaf, viz., to intercept the passage of liquids, and to destroy the cohesion between the leaf and its support whilst awaiting a more energetic cause to achieve the definitive separation. Such, in our opinion, is the part performed by the peridermal tissues.

As for the more active cause, we find it principally in the action of cold. Suppose a sudden fall of temperature, and notice the behaviour of the two kinds of tissues in its presence; it may be predicted that either one or the other will contract under the influence of cold, but the tissue at the base of the petiole, spongy, full of air, and elastic, will contract to a greater degree than that of the pulvinus, which presents different physical characteristics, and of which the change in bulk will be hardly appreciable.

These unequal shrinkages will result in the rupture of a certain number of cells at the junction of the two organs, and let but a slight shock come, and the separation will be complete But let the fall of temperature pass + 4 C* the shrinkage will not confine itself to an unequal retraction of the tissues; it will produce a true movement in opposite directions, in consequence of the dilatation of the dense and succulent parenchyma of the pulvinus opposed to the ever growing contraction of the spongy tissues of the leaf-stalk.

Thus the fall of temperature gives rise to congelation, and the expansion accompanying the solidification of the juices in the pulvinus becomes so great that all cohesion is destroyed, the rupture takes place at once, and the leaf drops.

These physics of the question explain the large increase in the number of fallen leaves after a sharp night in autumn, the least breath of air then bringing down the disorganized leaf; they likewise explain the sudden and complete stripping of trees by the early frosts, when the leaves falling by their own weight sometimes form, even round the foot of the tree itself, a layer of considerable thickness.

VII.—Physiological Conclusions.

The peridermal tissue, which is only found on the exterior parts of plants, naturally a bad conductor of heat, and impermeable by

* 39 2° Fahr., maximum *density* of water.

both liquids and gases, seems specially intended to protect the plant against the hurtful influence of the atmosphere. It is produced upon the stripped surfaces of the cortical parts, we have seen it isolate the leaf of which the life is ended, from the bough which remains full of sap and life; it even shuts off sickly or dying parts of the stem, and its appendages (for instance, unhealthy tubers), so that we may assign to it the term of scarforming, or cicatrising, tissues (*tissu végétal cicatrix*).

When we think of the large number of leaves which adorn the branches of a tree, each of which, falling, leaves a small surface made bare; when we think of the enormous wound which these little surfaces would make when added together, if they were not already sloughed over when exposed to the air: we may understand how important a part the peridermal tissue has to play for the conservation of the individual plant. It not only prevents an excessive loss of liquids by hindering evaporation at the surface of the wound, but it also preserves it from the hurtful influence of damp and decay.

Therefore, we can only regard it as an admirable provision of nature that the development of this new tissue, after having served to separate the leaf from its support, acts as a protection to the latter during the approaching winter, by preserving it alike from cold, wet, or drought.

Translator's Note.—I have brought these observations of Dr. Ledeganck under the notice of the Quekett Microscopical Club, in the hope that it may prove an incentive to work on this most interesting subject. For myself, I hope next autumn to attempt the task, my chief regret being that this memoir came under my notice too recently to permit of observations being made this season which would be trustworthy or useful.

The Best, the most Simple, and Unerring Tests for Objectives.

By William Webb.

(*Read December* 27, 1872.)

In submitting this paper for your consideration, I pray that so much of the verbiage as *primâ facie* may appear to be egotistical or presumptive may be treated with kindness, and not allowed to prejudice your minds until the whole paper has been read, discussed, and calmly considered. A double apprenticeship to the study and practice of the subject enables me to speak in terms so confident and positive that I fear to give offence, even in the initiatory title, viz. :—"The best, the most simple, and unerring tests for objectives."

Apologizing, in this company, for saying what is required of a Test is of Definition, Flatness of Field, and Distortion.

In speaking of definition in most instances I have adopted square measure, but where practicable I have expressed my words in lineal measure.

To view distinctly the five thousand millionth of an inch is good definition. To view the same space with equal distinctness all over the field is flatness of field. To view an object, and to find it presenting an abnormal state, is distortion.

I now propose to treat the Definition and Flatness of field together, and to submit that there is no test so certain as a series of engravings on glass. For my purpose I engrave a series of plates with letters measuring from one two hundred thousandths of an inch to one two hundred millionths of an inch. Each engraving is of the Lord's Prayer, varying only in size, commencing about the thousandth of an inch, which is at the rate of over a quarter of a million letters to the inch, and progressively decreasing the size, the next of the series being at the rate of a million letters to the inch, the next two millions, the next three, and the next four million letters to the inch. Having reached this point, and finding

the Old and New Testament together consist of three million 566 thousand 480 letters (for the convenience of a stand-point), I say the lastly enumerated test is at the rate of one Bible to the inch and then engrave the next at the rate of another Bible to the inch, and go on decreasing at the rate of a Bible to the inch down to fifteen Bibles, or, at the rate of fifty-three million four hundred and ninety-seven thousand two hundred letters to the inch; but when it is remembered that the letters are written within two parallel lines, with spaces above and below for long letters, and to enable one line to be distinguishable from another, I most respectfully submit that, such letters as "a," "e," "o," and "u," although averaged, with all other letters, with the capitals, and including spaces, at the 53,497,200th of an inch, being actually written within the lines, after allowing for the extra space occupied by capitals, the spaces between words, and the space between one line of writing and the next line, it may be taken that the "e" actually occupies only one-fourth of the average, or, the two hundred and thirteen million nine hundred and eighty-eight thousand eight hundredth of an inch.

The measurement does not stop at this point, as there are other steps to be traversed—one, as to the dot to an "i," I say nothing now. As to the "e," it is self-evident that it is not a spot of black of the previously estimated less than 200 millionth of an inch, but composed of a bent and twisted line across, and about the 200 millionth of an inch; therefore, the thickness of the line has to be considered, and, taking that at a lineal fifth of the space, the 200 and odd millionth would have to be multiplied by 25 as the square of 5, which would bring the square of the line down to the five thousand three hundred and forty-nine million seven hundred and twenty thousandth of an inch—and do not stop there, for that five thousand millionth is itself loaded in, and consists of abraded black atoms, grated in by the cutting edge of the glass letter, which atoms can be seen in different aggregations where the line has not been perfectly filled in, and if at the rate of two atoms of black in the square of the line, the five thousand millionth becomes the ten thousand millionth; if at the rate of twenty atoms of black, the size of the atom is the one hundred thousand millionth of an inch.

I now come to the most important and, to my mind, the most

interesting part of the subject which deals with the tests unblackened. For this purpose I must go back to the square of the line forming the letter as the 5,349,720,000th of an inch that, reduced to its square root, gives 73,000 + of an inch linear as the breadth of the line.

I mount the same series of slides in the way that Monsieur Nobert mounts his justly celebrated tests—without black—and thus open up a wonderful means of study of the whole subject, helping to afford the power of determining at what breadth unblackened lines become invisible, even when aided by the microscopes of the present day. In this instance the 73,000th is an absolute line, unbroken by a next line.

When viewing the black lines ordinary direct illumination is sufficient, but when examining the unblackened lines it becomes necessary to adopt in its turn every available means of illumination, because the cut, being wedge-shaped, each side of the cut, from every part to its very apex, both refracts and reflects again and again the light from the other. Again, the original upper and lower surfaces of the glass refract and reflect the light backwards and forwards ; again, the top light flows into the cut, helping to produce the climax which blazes away the cut as the light of the sun overpowers or destroys the light of a candle.

By testing by blackened and by plain unblackened letters, it will be found at what point the power of certain objectives ceases to be effective with transparent objects. I can define the smallest Lord's Prayer when blackened, that is, I can define a line of the 73,000th of an inch, but have never been able to define the same test unblackened. More than that, although I know the exact spot that it occupies, and mark the spot with an Indian ink ring before it leaves the machine in which it is engraved, I have never (perhaps because of irritable temperament) been able to discover not merely the line, but the aggregation of lines forming the 227 letters of the very small tests, although they become perfectly distinct when black.

If I shall be honoured by a full and exhaustive discussion of this paper I may be delighted to submit to the Club another paper upon the clever productions of M. Nobert, in the hope that I may be able in some way to assist others who may not so fully have studied his wonderful works, in arriving at a just appreciation of M. Nobert's extraordinary, patient, and persevering skill.

It is not necessary to possess more than a short selection of my tests to include general purposes, and in some particular cases a single test will be sufficient.

I now pass to the remaining part of the subject, viz., Distortion, which I believe is not so well understood, simple as it is. For this test I rule a slip of glass with fine black lines, and place it upon the stage, I then rule a disc with black lines and drop it upon the diaphragm of the eye-piece. If the disc be not in focus I turn back the screw of the eye-piece glass, or if this be not sufficient I shift the diaphragm until I get my focus. I then bring the lines on the stage into focus, and parallel with the eye-piece lines. If the objective shall be found to have the usual distortion, it will instantly be seen that although the central stage line is straight and perfectly parallel with, and covered from the top to the bottom of the field by the central eye-piece line, yet the other stage lines bend their ends in a curvi-linear direction from the centre of the field. Upon moving the stage the line that appeared straight assumes the circular form, and one of the bent lines gets into the centre and assumes its straight appearance, and so on, at every motion of the stage.

Upon one occasion, working with a fifth, I was puzzled by a distortion of a kind I could not understand, and a distortion I had never before noticed. Upon resorting to my tests I found the lines bent not from their centre, but straight and parallel through half the lower part of the field, and through the upper three-quarters of the field they spread out like the feathers in the crest of the Prince of Wales. I then knew that the lens (perhaps by a blow or fall), had become displaced, so as to destroy its parallelism.

I shall be glad if discussion may evolve any better Tests.

The Ague Plant.*

Some years since I became interested in the statements of Dr. J. H. Salisbury, of Cleveland, Ohio, in reference to the germs of ague. Dr. Salisbury† believes to have discovered the malarial essence in the cells of certain Palmelloid plants. Desiring to investigate the subject, I sought for the plants described by him, in

* From "Grevillea" No. 6, 1872.
† See American Journal of Medical Sciences, 1866.

the ague bottom of the Mississippi river, opposite Keokuk, Iowa, lat. 10° 25′. Not being provided with a suitable microscope, I was unable to discover the microscopic algæ described by the doctor. I was pleased, however, to find the fungi, samples of which I send you. Generally it answers Salisbury's description.

It does not correspond in these important particulars : Salisbury's plants are so minute that it requires a powerful lens to render them visible. A single specimen of plant may be discovered as you stand. Salisbury's plants were not less. These have roots $\frac{1}{8}$ or $\frac{3}{16}$ of an inch in length. They grow on the flat moist alluvium of the slough and river margins and their drying beds ; in the vicinity of such localities they may be found on ordinary soil in damp places, even at some elevation. The specimens sent you are green ; I have observed them slate-coloured, pink, and black. They vary in size from a mere point to $\frac{3}{32}$ of an inch in diameter. When in natural state they are globular in shape and of a fresh colour, when covered with water they swell and present a gelatinous appearance. They discharge their spores when ripe by slitting open at the top and a falling in, collapsing of the upper circumference ; so that a discharged plant appears cup-shaped, and to the naked eye it seems to have lost the upper half of its circumference. So far as I have been able to determine with the imperfect means of observation at my command, the cells are composed of two walls, the outer green or (otherwise coloured), composed of laminated cells, the inner white and structureless. Upon puncturing the plants a liquid is forcibly ejected. I have never been able to discover the contained cells for want of a good microscope. By placing the cake of earth sent you in a plate, and adding water enough to make it of about the consistence of potter's clay, and keeping it at a temperature above 60°, you will find a fresh crop of the plant to develop, and you will thus have an opportunity of studying them. Should you allow them to flourish, and remain uncovered in your room, you might have the satisfaction of demonstrating the "cause of ague." This fungus was first found, so far as I know, by Dr. J. P. Safford, of Keokuk, who was kind enough to search for me while I visited an ague patient. In the locality of their growth they are to be seen in myriads, and near them, even on elevations of over 100 feet, everybody had the ague. The course of this disease seemed *pari passu* with that of the plant.

Dr. John Bartlett, Chicago.

PROCEEDINGS.

September 13th, 1872.—Conversational Meeting.

The following objects were exhibited :—

Scales of *Polyommatus Alexis*	Mr. Burch.
Section of Human Skin shewing Sweat Glands ...	Mr. Topping.
Surirella gemma under a $\frac{1}{25}$in., shewing longitudinal markings between the costæ ...	Mr. Hickie.
Lampyris noctiluca (alive and alight) ...	Mr. T. C. White.
Nerves of Teeth	Mr. T. C. White.
Polynema (Hymenoptera), alive	Mr. Fitch.
Striped Muscular Fibre	Dr. Matthews.
Selected Diatoms incident light ...	Dr. Matthews.
Spicula *Spongilla fluviatilis*	Dr. Ramsbottom.
Iron Pyrites in Flint	Mr. Ward.
Elytron of *Lordops Gyllenhalii* ...	Mr. Ward.
Diatomaceæ and Ichaboe Guano	Mr. Goodinge.

Attendance—Members, 44; Visitors, 4.

September 27th, 1872.—*Chairman*—Dr. R. Braithwaite, F.L.S., &c., President.

The minutes of the last meeting were read and confirmed.

Dr. Braithwaite, in occupying the chair for the first time since the annual meeting as the President of the Club, hoped that the progress of the Club would still be continuous, and promised a short series of papers on Elementary Botany. He said—I may take the opportunity of my first occupation of this chair to say a few words on the present and future of the Quekett Microscopical Club. My position is somewhat like that of a captain on taking charge of a new ship—his first duty will be to inspect the vessel, and see if the timbers be sound, and the sails and rigging in good order ; and on this score I feel there need be no misgiving. The next point is, as to the cargo our ship is laden with on each monthly voyage into this excellent port ; is it valuable grain, with now and then some precious stones, or is it only unprofitable ballast ? I fear we have drifted a little into the " rest and be thankful " condition, and in considering what more might be done to render the Club useful to the members at large, it has struck me that there are many groups in Natural History which, if treated somewhat exhaustively, would yield valuable instruction to all. For instance, in a few months you will have in your library Sir J. Lubbock's great work on " The British Thysanura." With such a guide, what could be more delightful than to

have the structure and habits of these interesting little animals brought before us by one of our members who is known to be well acquainted with the subject, and the whole illustrated by the microscope ; and so with other groups ? Then there is the great and important department of Histology—Animal and Vegetable. What subject could do more honour to the name of Quekett than this ? That precept, however, may not be without example, I purpose to bring before you a few papers " On the Elementary Tissues of Plants," but not to the exclusion of those shorter communications which often prove such an interesting feature in our proceedings.

The following Donations were announced :—

"The Monthly Microscopical Journal"...	... from the Publisher.
"Science Gossip"	,,
"Proceedings of the Royal Society," No. 136 ...	the Society.
" The Journal of the London Institution " ...	the Institution.
"The American Naturalist"	in exchange.
" The Archives of Science of Orleans County Society"	,,
" The Smithsonian Report for 1870 "... ...	,,
Nine Slides for the Cabinet	Mr. Arthur Cottam.
Four Slides...	Mr. Martin Burgess

The following members were elected:—Edward Bartlett, jun., Rt. Hon. Lord Borthwick, William Bugby, William Bush, Chas. T. Conolly, L.S.A., His Grace the Archbishop of Westminster.

Paper by Mr. John E. Ingpen, F.R.M.S., " On a New Standard Dynamometer for ascertaining at once the magnifying powers of Microscopical Objectives."

Paper by Mr. D. E. Goddard, " On the Value of Comparative Study."

Mr. Jas. W. Ward, of the New York Bailey Club, one of the visitors of the evening, being called upon by the President, said he would take the opportunity, so courteously offered, to express the great gratification he had experienced in being able to attend several meetings of the Quekett, with whose proceedings those of his own little club at home, which was formed especially for work and study, were so much in harmony, though moving in a much smaller field. In regard to the subject which had mainly occupied the attention of the meeting this evening, he would say he was glad to find it was one the importance of which was recognised by the gentlemen he had the pleasure of addressing. It had received considerable attention in America ; the initiative of the discussion having really been taken by the club he had the honour to represent, and it was now very generally felt that a reform in the rating and estimation of objectives was widely called for. It was of the utmost importance in any serious microscopic examination, to be assured of the exact power of the objective under employment; not only for the purpose of comparing the relative capabilities of different objectives, but more particularly of knowing accurately and at all times the exact amplification of any object or material submitted to examination. The present method of rating objectives was quite inaccurate, and could not be relied on for the information desired. He thought that makers ought to be required—perhaps compelled would not be too strong an expression—to stamp upon each of their objectives its magnifying power, irrespective of eye-piece. Every objective has a fixed magnifying power *per se*, of which its actual amplification, in any case of use with the complete instrument, is only that power multiplied by the power of the eye-piece ; and that particular power of each

objective should be ascertained and engraved upon it—if not by its maker, then by some standard authority, such as has been proposed here this evening. Mr. Ward also said he would call attention to the curious material exhibited by Mr. Topping on one of the stands. The substance entered into the composition of a shelly rock of the Tertiary series, forming extensive elevated beds in Western Iowa. He had brought some fragments with him from the United States, from which Mr. Topping had prepared a few slides. The substance would be found interesting in many respects. It was found embedded in the coarse cement, or matrix, which held together the constituent shells of the rock, the general character of which was cretaceous; but this material would be seen to be composed of minute globular grains of silex, without cement or admixture of any kind. Each grain was a microscopic globe of silex, perfectly transparent and free. In water they would be seen to roll about like marbles. They were less than the $\frac{1}{1000}$ of an inch in diameter, and when laid out in quantity, flat upon a slide, they would each show the transmitted image of any suitable object held below the stage, as was the case with the facets of the eye of a beetle. On breaking up the hard, granular matrix of the rock it would be found to contain, mostly in a fragmentary state, the frustules of half-a-dozen species of fresh-water diatoms, interesting to any who may still be sceptical on that question, as proving, incontestably, the existence of very ancient fossil diatoms.

The following objects were exhibited :—

Diatoms and Podura Scale, with dark ground illumination	Mr. Geo. Williams.
Injected Voluntary Muscle of Frog...	Mr. A. Topping.
Acari of Bat	Mr. J. A. Smith.
Alcyonella stagnorum	Mr. Geo. Burch.
Acarus of Phalangium (alive), and various Insect Mountings (dry)	Mr. Fred Fitch.
Arrangement for Protecting High Powers when in use	Mr. E. Richards.
Triceratium armatum Acari of Sparrow	Mr. J. W. Goodinge.
Globular Silica, from America	J. W. Ward, of the Bailey Microscopical Society, U.S.A.

Members present, 73 ; Visitors, 12.

October 11th, 1872.—Conversational Meeting.

The following objects were exhibited :—

Insects (various) from Ceylon	Mr. Hailes.
Injected Tendon of Horse	Mr. A. Topping.
Turbot scale	Dr. Matthews.
Seed of *Sphœnogyne speciosa*...	Mr. Golding.
Section of Spinal Cord (human)	Mr. Curties.
Daphnia pulex (alive)...	Mr. Martinelli.
Male Gnat, with parasites Exuvium of Froghopper	Mr. Fitch.
Nostoc commune	Mr. Ingpen.
Galinsoga parviflora (fruit)	Mr. Jackson.

OCTOBER 25th, 1872.—*Chairman*—DR. R. BRAITHWAITE, F.L.S., &c., President.

The following Donations to the Club were announced :—

"The Monthly Microscopical Journal"...	...from the Publisher.
"Science Gossip"	"
"The Popular Science Review"	"
"Proceedings of the Royal Society," No. 137,...	the Society.
Annual Report and Proceedings of the Bristol Natural History Society...	"
A Paper on *Callograptus radicans*, by Mr. John Hopkinson	the Author.
"Proceedings of the Geologists' Association"...	the Association.
"The American Naturalist"	in exchange.
Six Slides	...from Mr. Thos. Rogers.

The thanks of the Club were unanimously voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club :—Mr Frederick William Andrew, junr., Mr. Charles G. Dunning, Mr. E. W. Jones, Mr. W. H. Price, Mr. Phillip Vallance, and Mr. James Watkins, L.C.P.

The President then called upon Dr. Lionel S. Beale to read a paper.

Dr. Beale delivered a highly interesting communication upon "Bioplasm," illustrating the subject by means of colored diagrams.

The President felt sure that all the members present would join very cordially in a vote of thanks to Dr. Beale for his very valuable and interesting remarks. Not having been able to follow up the subject practically, he was not himself qualified to speak upon it, but he must confess that his convictions went greatly with Dr. Beale in the matter. One thing just occurred to him in connection with the subject, and this was that they found that after the greatest care had been taken to exclude living particles from liquids, yet life had been developed even after the liquids had been exposed to great heat. There must, he thought, be some fallacy in supposing that such particles had been destroyed; and perhaps Dr. Beale could tell them where this fallacy laid ?

Mr. B. T. Lowne said that there was, of course, a great deal in Dr. Beale's remarks with which he most cordially agreed, but he must also say that there was a great deal with which he most cordially disagreed. He would not, however, enter into the subject then, but would like just to ask why the word vital should be so much more easy to understand than the word molecular ? Molecular means what we know so little about, and vital is a term about which we think we know something, but about which really we know very little.

Dr. Beale said he feared that it would not be possible then to go into the question raised by the President, seeing that it would lead them into the tremendous subject of *spontaneous generation*, and perhaps, after all nothing which he could say would influence those who were believers in it. For his own part, he could only say that after a most careful study of the arguments in favor of the doctrine of spontaneous generation, heterogenesis, or abiogenesis, and a careful examination of the experiments which were adduced in its support, he could not see good reason for accepting them as at all conclusive, although there were undoubtedly a great many persons of high standing—Pouchet, Owen, and many more—who thought otherwise. One thing seemed to him very remarkable, namely, that every living form which had been "produced" in the

course of heterogenetic experiments was exactly like the living forms which were known and admitted to have been produced from parental organisms. He disliked to discuss this subject because he felt he could not do so freely without offering severe criticisms and wounding the tender feelings of the faithful believers in the heterogenetic idea. He would have to remark that drawings were not correctly made, and did not truly represent what it was assumed had sprung from non-living matter. He would have to comment severely upon the kind of evidence that had been accepted as conclusive, and had been stated to be thoroughly trustworthy. He would be obliged to bring forward evidence to show that bodies figured were not what they were described; and it was obvious this could not be done without offending those who put their trust in spontaneous generation and subscribed to articles of belief concerning which he (Dr. Beale) was a miserable sceptic, unconverted and unbelieving, not only destitute of faith, but wanting in the ability to acquire the least spark of faith. He even went so far as to think that the whole question might be upset merely on the ground of extreme improbability, for to him the development of the living direct from the non-living appeared one of the most improbable things that could be conceived. They all knew that millions of known forms all came from previously existing forms, but they were called upon to believe that a very few living things originated in a totally different manner, and in obedience to laws totally distinct in their nature from those which governed the rest of creation. And this, notwithstanding the fact that the gulf between the living and the non-living became wider and deeper the further minute investigation was pushed. Of course, people would say that he (Dr. Beale) was a prejudiced "vitalist," but he would wish it to be borne in mind that he had worked at the subject for many years before he ventured to use the term vital at all, and he was quite prepared now to give it up as soon as anyone gave him a better one to distinguish the actions peculiar to matter that was alive. He did not contend for any particular word; they might call the matter A, B, or C matter, if they pleased; and the properties α, β, or γ properties or anything else. If the movements of an Amoeba could be shown to be of the same kind and due to the same causes as the movements of molecules or lifeless particles suspended in a fluid, he would admit them to be molecular movements, and admit that they might be due to the operation of inorganic forces. But, as far as he was able to observe, he felt quite certain that if such movements were molecular movements, they were certainly molecular movements of *a very different kind* from the "molecular" movements of lifeless particles suspended in a drop of water. The molecular motion of particles in fluid could easily be stopped by the addition of a little syrup, and they would recur when the fluid was diluted, but when the movements of living matter were once stopped they were never found to recur in the same particular particles of matter.

Mr. Lowne hoped that Dr. Beale did not give him credit for confusing these two kinds of movements, or that he supposed he would compare the movements of molecules of hydrogen gas to the movements of a little soot in water. He supposed it would be admitted that hydrogen consisted of molecules?

Dr. Beale said it was quite possible to stop the movements of the molecules of hydrogen and of soot, to change their character altogether, and afterwards to make them proceed as before, but they could not stop the movements of the living matter of an Amoeba and afterwards make them go on again.

Mr. Lowne thought that the molecular motion in hydrogen stops when that gas undergoes combination, and ceases to exist as hydrogen, only the same as

Amoeba when its chemical condition is changed. There were, he thought, instances where the motion of living particles was stopped and afterwards restored, as when living matter is kept frozen for many years without being destroyed. Salmon ova were frozen and afterwards developed; it was customary to send out salmon ova to Australia frozen and packed up in ice, and it was restored to its former condition again on arrival. If, however, ova are boiled, they undergo a chemical change, and no recovery takes place after, just because it is impossible to restore their original chemical condition. It must, perhaps, be admitted that they had no clear evidence to show that spontaneous generation takes place, although he (Mr. Lowne) looked forward to the day when he believed that evidence would be forthcoming ; at present the evidence was undoubtedly contradictory. He (Mr. Lowne) maintained that molecular changes in inorganic matter and those of the Amoeba were not different in kind, but only in degree.

Dr. Beale asked if Mr. Lowne could give him a single instance in which any kind of matter except living matter ever moved in different parts in many different directions at the same moment of time ?

Mr. Lowne, though not quite clear as to what was meant by moving in different directions at the same time, knew that a particle of colloid burnt sugar placed in a saucer of water would make movements quite compatible with those of Amoeba. With regard to death as a property of living matter, Mr. Lowne regarded it entirely as the effect of chemical change and altered conditions.

Dr. Henry Lawson thought that it was almost useless to carry on the discussion, seeing that it involved so many questions which could not at present be decided. Dr. Beale had in his paper brought forward opinions which he had already largely written upon, and which must be regarded as very valuable, but still he thought that with regard to the question of development, it must be considered for the present to be unsettled. Dr. Beale had, he thought, rendered great service, and had done more than anyone to get rid of the idea of cells, or certain circular or oval bodies containing a nucleus, being the starting points of all tissues; but admitting this, there remained the question whether it was the nucleus in the surrounding protoplasm which usually had to do with the development of the tissues. On this point he thought that they had as yet no evidence which would conclusively decide, and whilst he did not think that Dr. Beale had completely proved his case, and he himself leaned towards Wolff's ideas, he admitted that these were not so clearly proved in some cases as to entirely exclude the view taken by Dr. Beale ; and the only present conclusion to be arrived at was that there was a great deal to be said on both sides. He thought, however, that in the case of the development of bone, there was tolerably good proof that the so-called cell wall was concerned in the growth rather than in the nucleus itself. He thought that on examination of the structure of bone, evidence could be seen in its immature condition that the so-called cell wall was, in point of fact, the structural centre, and became the lacuna which frequently contained within it the dried-up nucleus. In making these few observations he was not attempting to enter into the subject generally, but rather to draw attention to the more valuable points in the paper. Personally he might say he was more inclined to Mr. Lowne's views than to those of Dr. Beale, but he was quite ready to admit that the question was as yet very far from being settled.

Mr. W. H. Golding suggested that it seemed doubtful whether they yet had any means of ascertaining what amount of heat or cold living matter was

capable of enduring. To him it seemed only common sense to suppose that there was a difference between living matter and non-living matter ; and when it was said that certain solutions had been subjected to heat which had destroyed all living matter in them, and when afterwards living matter was found to exist there, did it not prove only that they had found something which that amount of heat was insufficient to destroy ?

Dr. Beale said that with reference to the remarks of his friend, Professor Lawson, as to the development of bone, he could only say that bone, of all tissues, was the one which he should have brought forward as being of all things most likely to prove his point ; he had elsewhere, he thought, fully shown this, and had given drawings from actual specimens for the purpose of illustrating the whole process of the development of bone from the simple bioplasts. Of course his views were true for *all* or *none*, and if any one could give him but one single clear instance against his conclusions, he would at once give up. Of course it must be a distinct proof, and one which would in every respect stand the test of thorough examination, and could be readily verified and repeated by others. He was quite sure that Mr. Lowne had never seen a piece of protoplasm frozen in his life. He (Dr. Beale) did not think that living matter that had ever been actually frozen had continued to live. That a living animal, or a part of a living animal, might be frozen without being "killed," was, of course, perfectly true, but who had proved that its *living matter*, *its bioplasm*, had been converted into solid ice?

Mr. Lowne observed that, at all events, when it was thawed, it became protoplasm again.

Dr. Beale—continuing his reply—pointed out that he did not contend that new living matter, produced by existing living matter, was *identically the same* in all respects as that which produced it ; there was not identity ; there was variety in many particulars, and this variety, in property and power, was a most remarkable thing, especially when considered in connection with transmitted characteristics. It was well known that there were strong resemblances between offspring and parents, but never anything approaching indistinguishable resemblance. There might be likenesses not only in the shape of the nails and in the skin, but even in the way the mind worked, likeness in weaknesses of the body, and the defects of the workings of the mind ; even rheumatism and sick-headaches, as well as good and bad tempers, were inherited. So that while it was clear that there were many endowments as well as arrangements of the material fabric that were inherited, it was also true that certain properties, and powers,and endowments, as well as peculiarities in the structure of the body existed, which could not be accounted for by inheritance. But every kind of living matter in the world, whatever might have been its origin, possessed properties like those manifested by every other kind of living matter, but differing essentially from any properties or powers known to exist in connection with any form of non-living matter. With regard to Mr. Lowne's instance of the burnt sugar, if he could show that the particles of burnt sugar were capable of taking up material from the medium in which they were placed, and turning that material into burnt sugar, then, but then only, would he have succeeded in showing that the burnt sugar behaves as particles of living matter.

Mr. Lowne said that great stress should always be laid upon the word *suitable*, it was always *suitable* material which was taken up and made into similar matter. Now, if they took a galvanic battery, and conducted the wires to a solution containing salts of copper and salts of zinc, it was quite possible for a

compound of these two metals to be produced from the solution by the action of the current, and he could see no essential difference between the decomposition of salts of zinc and copper and re-combination of the products and decomposition of carbonic dioxide and ammonia with similar recombinations.

Dr. Beale, however, interposed, that to be comparable with living matter Mr. Lowne's galvanic batteries should be capable of producing little galvanic batteries.

The President thought that, as time was short, the discussion had better be brought to a close. It was quite clear that the question was not yet decided, though he thought that Dr. Beale had shown very good grounds for his opinions, and that the term vital was one which could not be objected to.

Mr. English exhibited to the meeting, and described by means of diagrams, a new kind of apparatus for injecting, and explained the method which he had successfully adopted. It being then (from the lateness of the hour) impossible to show its action practically, he undertook to give a demonstration of the process of injecting a small animal at the next conversational meeting.

A vote of thanks to Mr. English was unanimously carried.

The proceedings then terminated with a Conversazione, at which the following objects were exhibited :—

Lamp Micrometer	By Mr. Burch.
Palate of *Haliotis tuberculata*...	Mr. Catchpole.
Section of Human Skin, shewing the growth of a wart	Mr. Curties.
Scales of Foreign Butterflies, arranged as a bouquet	Mr. Fitch.
Head of *Vanessa*	Mr. Golding.
Tooth of Medicinal Leech	Mr. Goode.
Transverse section of *Gunnera scabra* ...	Mr. B. D. Jackson.
Desmids and Amœbæ (alive)	Mr. McIntire.
Argulus foliaceus	Mr. Martinelli.
Parasite on Wireworm (alive)	Mr. J. A. Smith.
Section of Glandular Stomach of Fowl ...	Mr. A. Topping.
Cyclosis in Nitella	Mr. T. C. White.

Attendance—Members, 91 ; Visitors, 18.

R. T. Lewis.

November 8th, 1872.—Conversational Meeting.

The following objects were exhibited :—

Cuticle of *Gasteria ensifolia* (polarised)	Dr. Matthews.
Desmids, Rotifers, &c., from Oban (gathered 19th July, 1872)	Mr. F. Fitch.
Section (transverse) Medicinal Leech	Mr. Topping.
Salticus scenicus (alive)	Mr. T. C. White.
Grantia compressa	Mr. T. C. White.
Longitudinal and transverse chippings of Cuttle Fish Bone	Mr. T. C. White.
Diamond Gravel from the Klip-drift Diggings, S. Africa	Mr. T. C. White.

Eggs, Larva, Larva Case, Pupa, Pupa Case, and Imago of *Laverna sarcitella* ...	Mr. Jas. Russell.
Impression in wax of the Chambers and Passages excavated by Parasites in the substance of an Oyster Shell	Mr. Hawkins Johnson.
Series of Whole Insects	Mr. Geo. Daintrey.
Cyclosis in *Anacharis alsinastrum*	Mr. Martinelli.
Gemmules of *Spongilla fluviatilis*	Mr. Moginie.
Under Surface of Leaf of Laurustinus	Mr. Curties.
Scales of *Papilio Paris*	Mr. J. A. Smith.
Stephanoceros Eichornii	Mr. Geo. Williams.
Demonstration of Injection by New Injecting Bottle	Mr. English.
Ruling on Glass by means of a Vibrating Rod ...	Mr. Burch.

Present—Members, 53; Visitors, 8. Total, 61.

NOVEMBER 22nd, 1872.—*Chairman*—DR. R. BRAITHWAITE, F.L.S., &c., President.

The following Donations to the Club were announced :—

"The Monthly Microscopical Journal"... ...	from the Publisher.
"Science Gossip"	,,
"The Sixth, Eighth, and Ninth Annual Reports of the Belfast Naturalists' Field Club"	the Society.
"The Journal of the London Institution" ...	the Librarian.
Nine Photographs of Nobert's Test Plate Bands Two ,, Amphipleura Pellucida One ,, Frustulia Saxonica with reports thereon	Dr. J. J. Woodward, U.S.A. Army Medical Department.
A paper on the Glacial Drift of North London, by Mr. Henry Walker	the Author.
A paper on a New Form of Pocket Microscope, by Professor G. T. Brown	the Author.
Ten Slides for the Cabinet...	Mr. Hainworth.

The thanks of the Club were unanimously voted to the donors.

The following gentlemen were balloted for, and duly elected members of the Club :—Mr. A. C. Goodchild and Mr. Thomas Spencer, F.R.M.S., F.C.S.

Mr. B. D. Jackson read the translation of a Belgian paper "On some Histo-Chemical Researches upon the Fall of the Leaf in Autumn," which he illustrated by sketches upon the black board and by coloured drawings.

The President felt sure that all the members present would join in a cordial vote of thanks to Mr. Jackson for the spirit which he had shown in making this translation, and bringing it before their notice. It should, however, be mentioned that the views expressed by the Author were not new, for the same explanations of the phenomena had been made by Dr. Inman, of Liverpool, as far back, he believed, as 1848. He named this because he thought they ought not to allow these Germans to annex everything in that manner. Dr. Inman, at the time to which he referred, showed clearly that the fall of the leaf was pro-

vided for from the earliest stages of the growth of the plant; he did not, however, make use of the term "corky," nor did he speak of "cork cells," because at that time it was not so generally known that the material was so nearly allied to that of cork. The fall of the leaf was before their eyes constantly, and was on that account likely to be little noticed; it was, however, an occurrence of great interest, and became increasingly so when it was found to be provided for in the manner described, in the early growth of the plant, and when the arrest of growth and the deposit of the cork cells was understood. He thought, however, that there were some other circumstances which had at least some slight influence in contributing to the fall of the leaf. It was found that the ashes of dead leaves contained more of the salts of lime and potash than the ashes of living leaves; and if there was an increase in the deposit of solid constituents, this would undoubtedly add to their brittleness. He thought, also, that the changeful nature of the climate in autumn must have considerable influence on the mechanical relations of tissue, which had ceased from active growth. In the tropics most of the trees were evergreens, but they cast their leaves at intervals, and it was noticed that after a very dry season they threw them off more frequently than was the case after wetter seasons, showing thus that climate had much to do with the process. The corky substance was found also in many other portions of plants—the cuticular layers, for instance, had it, and it gave hardness to many other parts. He thought that Mr. Jackson had done what was very meritorious in reading them this Paper, and he hoped the example would be followed, and that other members would be induced to bring forward translations of similar papers on common subjects – for although this was a common subject, it was treated, as they had heard, in a very scientific way. It did not show all that could be brought forward to explain the subject, but it was a paper of much interest, and showed them an example of the wisdom of God in making provision even in the early growth of the plant for that which was to take place during its later existence.

Mr. Thos. Spencer said that he happened to be present on the occasion when his friend Dr. Inman read the paper which had been mentioned. It had always struck him since then, on thinking the matter over, that trees which secreted resin did not show a general fall of the leaf. All that was stated in the paper hardly explained this fact, which was noticed in the holly, fir, and laurel. He thought that in those cases the varnish which was secreted prevented evaporation from taking place.

The President said that the evergreens shed their leaves as well as other kinds of trees, though they did not do it quite by the same process. He did not think that the resin had much to do with it.

The Secretary thought that analogous cases were to be found in the animal kingdom, and instanced the shedding of the horns of the stag, in which circulation, after going on for a long time, at length ceased in consequence of the deposit of calcareous matter at the base of the antlers, and nutrition having been thus arrested the antlers fell off as effete bodies.

The President said that Mr. White was quite right in referring to this circumstance; in fact, similar processes might be found going on throughout creation. The fall of the leaf had, however, always been a topic of interest, and was a favourite simile with the poets in all ages,—the leaf being taken as a type of human existence, – its early unfolding from the bud was aptly compared to the opening character of childhood,—its beauty and its greenness to the period of juvenescence, and so on to its fading and its fall as types of sere old

age and dissolution, and its corruption and renovating effects upon the soil as continuing the cycle of fresh existences.

A vote of thanks to Mr. Jackson was unanimously carried.

Mr. Ackland called the attention of the members to the circumstance he had mentioned at the last gossip night—of his having found an extraordinary mass of diatoms some time ago whilst travelling in Switzerland. The position was easily found, and he hoped if any members were going to the place they would notice whether the same mass was to be found there still. He had travelled over the Furca pass in the month of July—and they would be able to judge of the season, when he mentioned that the snow laid upon the pass about three feet deep—from the Furca he descended by the road to the Rhone Glacier, and having rested at the Hôtel du Glacier du Rhône proceeded to visit the glacier from which the river flowed. At the glacier there was a hut in which the guides stayed, and where refreshments could be had, and having passed this he noticed a large mass of a chocolate-brown substance, which could not have been less than forty feet long, and about ten feet wide and eighteen inches thick. His attention was attracted by this mass, and he at first thought it must be oxide of iron, but on taking some into his hand and squeezing it moderately dry he found that such was not the case. He, therefore, collected some, and when he reached home found it to be a mass composed entirely of diatoms—chiefly Odontidium. Last year he went to the Upper Valley of Lauterbrunnen, and visited the Glaciers and the Schilthorn, but could not there find anything of the kind. He had brought with him to the meeting an abundant supply of these diatoms for distribution amongst the members.

Mr. Ingpen exhibited and described an instrument which had been constructed for him by Mr. Curties for the purpose of ascertaining the power of microscopical objectives.

A vote of thanks was passed to Mr. Ingpen for his communication.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Drawings of Microscopic Objects... ... ... by	Mr. Rochfort Connor.
Dolichopus trivialis (Fantail Fly)...	Mr. Curties.
Presumed Mode of Attachment of Web of *Epeira Diadema*...	Mr. Fitch.
Ichaboe Guano	Mr. Goodinge.
Chalcedony (polarised)	Mr. Hainworth.
Section of Brain of Rabbit	Mr. Oxley.
Foraminifera from Egyptian Limestone ...	Mr. J. A. Smith.
Section of Potato, shewing Starch Grains, *in situ*	Mr. Tafe.
Injected Bone of Bird	Mr. Topping.
Batrachospermum moniliforme	Mr. J G. Waller.
Young Actiniæ (Gemmacea)	Mr. T. C. White.
Freshwater Shrimp (alive)...	Mr. G. Williams.

Attendance—Members, 82; Visitors, 7.

R. T. Lewis.

On the Histology of Plants.

By R. Braithwaite, M.D., F.L.S.

1. Structure and Contents of the Plant Cell.

(*Read January* 24, 1873.)

In the subject I now bring to your notice, I have no original investigations to offer; my aim has simply been to place before you the more important facts so ably treated on by Von Mohl, Pringsheim, Sachs, and Dippel, trusting that, in a field so rich, some of our members may become workers, or at least recipients of something novel or instructive.

Linnæus despised the microscope, and all information it supplied, and hence was far behind his predecessor Malpighi in a true knowledge of vegetable structure, but Mirbel, Amici, Schleiden, Von Mohl, Hoffmeister and others, have in our own times taken up the thread dropped at the end of the seventeenth century, and laid before us in all its minuteness and perfection the wonderful fabric of plant organization.

If we set before us a part of one of the higher plants, a branch or a leaf of this Magnolia, for instance, we require but little magnifying power to observe that it is built up of very different elements—of pith, and wood, and bark, in the former, and of a central fibro-vascular skeleton and pulpy parenchyma, protected by a hard cuticle or skin in the latter. Yet, if we trace back the growth of such a tree to its parent seed, and examine the embryo of that seed from which the whole has been developed, we find no such distinctions, but only uniform cells; and if we turn to the animal kingdom, the case is the same, for from the cellular germinal vesicle of the ovum is developed by its inherent life forces, the bone and muscle, the blood and brain, that constitute the living entity of each one of us now present. Again, as we descend the scale equally of animal and vegetable existences, we find less differentiation of parts, until we arrive at those lowest members of each, where, within the

limit of a single cell, is comprised the whole life history of the individual—birth, nutrition, growth, reproduction, death.

Neither can any distinction be found between the primitive animal and vegetable cell, and since all organized creation thus originates, the study of a cell becomes invested with an importance that can scarcely be over estimated, and with that study we must commence our investigations, if we would rightly understand the wonderful changes brought about by the vital processes in the multiplication and metamorphosis of cells consequent on growth.

Structure of the Plant Cell.

Each individual cell is an independent microscopic organism, which, according to the latest theory, is in its primitive state, like the animal cell, deficient of any enclosing membrane, and consists essentially of a little lump of protoplasm, enclosing the cell nucleus.

The constituents, however, of the primordial cell are usually regarded as being—

1. The cell membrane, composed of an albumenoid substance.
2. The cell contents, separable into protoplasm and cell sap.
3. The cell nucleus, a small body suspended in the protoplasm, and composed of smaller nucleoli.

At a later stage of its life, the primordial cell becomes surrounded by a second membrane, a case or capsule, *the cellulose case*, composed of carbon, hydrogen, and oxygen, the presence of which distinguishes histologically the plant cell from the higher animal cell.

We meet with the vegetable cell in its first stage of development, in the zoospores of algæ, the spermatozoids of mosses and ferns, as the germ cell of all plants, as the first endosperm cells in the unimpregnated embryo sac of many families, as Liliaceæ, Umbelliferæ, Papilionaceæ, &c., and as young pollen cells in the cells beginning to form pollen by cross-division, which are best observed by section of young buds.

The next step in the investigation of the free cell, is the observation of the stage when it has formed the first envelope of cellulose, the primary cellulose case. This condition, hitherto the basis of definition of the living vegetable cell, is truly only a certain stage of perfection of the same, and is at once evident by the double contour of the circumference, and the firmness of the whole; the

impregnated germ cell, and the loose cells of the fleshy fruit of cherries or strawberries supply material for its observation.

1. The Cell Membrane.—Primary cell membrane—Primordial utricle of Mohl—is recognised by its single strong contour, the outline being smooth, or granular from pressure of contents on the delicate membrane; in the germ cell it is extremely thin, so that water dissolves it, but in endosperm cells it is stronger, and by bursting the utricle in water, the contents escape, and a clear, slightly folded bladder is left. By chemical reagents we obtain distinctive coloration of the primordial utricle, watery solution of Iodine tinges it deep yellow, indicating its albuminous nature; dilute nitric acid and liq. ammonia a similar colour; sugar and sulphuric acid rose red; sulphate of copper and liq. potassa violet. The action of these reagents, as well as of syrup, alcohol, &c., which remove water, cause the cell membrane and its contents to shrivel. In cells where the cellulose case is also formed, the two membranes are so blended as to be optically indistinguishable; they may, however be isolated by endosmotic media, as sol. of sugar, salt, or iodine, and we see the primordial cell, like a little sac, closed on all sides, lying sharply defined within the cellulose case. The cell membrane *alone* takes an active part in the life phenomena of the cell, the cellulose case does not do so in any way.

2. The Cellulose Case.—Cell case, cell wall, or cell membrane of botanists—is, next to the enlargement of the primordial cell, the earliest product of the organic vegetable formative principle, and adapted to serve as a protective covering to the cell. It is also the most enduring part of it, for after all active life has ceased in the nucleus and cell membrane, the cellulose case may remain entire for an indefinite period.

For the study of the cellulose case the best adapted is the free cell, as when combined into tissues their super-position and contents greatly interfere with distinct observation; the first envelope, however, which separates after the cell-membranes does not become the cellulose case, but undergoes further transformation; for certain purposes, however, as the determination of structure, surface-markings, &c., the separated tissue elements supply the best material. As soon as the cellulose case has separated from the primordial membrane and become firm, it becomes evident under a power of 350 diameters, by its double bounding line, and appears quite hymogeneous. Chemically, it agrees in constitution with the

carbo-hydrates, and in a more advanced stage it consists of pure cellulose, but in the youngest state of development it appears to be intermediate between this substance and starch, which in a few cases, as in fungi and the cambial walls of tissue cells is not further altered, and is believed by Wigand to consist of Bassorin. Neither the solution of chloro-iodide of zinc, nor aqueous sol. of iodine with sulphuric acid, give any colour to the entire cambial cell-case of completed tissues; but in Algæ, where the cellulose case is distinct and firm, or where, as in the young tissues, the primary cellulose case is deposited within the cambial wall, Schultz's test produces a more or less blue coloration.

3. The Cell Nucleus—Cytoblast of Schleiden—occurs in the living cells of all plants, though in fungi and lichens it cannot always be detected. The nucleus is best observed in loose, soft tissues, as cucumbers, beans, stems of liliaceous plants, and the young hairs on leaves and sepals. In form it is lenticular or sub-globose, and its position is usually close to the internal wall, or more rarely near the centre of the cell. In many cases a true membrane invests the nucleus, but in others it cannot be demonstrated, though most probably it is always present, and in the fluid, granular, or waxy contents, lies another important element —the *nucleolus*, either single, in pairs, or many to each nucleus. In its chemical reaction the nucleus entirely agrees with the primordial membrane. Solution of carmine is readily taken up by it, the nucleolus being most strongly coloured; an immersion for 24 hours is necessary, and then washing in water with a few drops of acetic acid.

4. The Cell Contents.—These may be distinguished into *Protoplasm*, a viscid, granular fluid, forming a layer next the wall, and *Cell sap*, more watery and occupying the inner space of the cell. Certain firmer organic and inorganic contents are also found suspended in the fluid contents. *Protoplasm* almost completely fills the young cell, and from it, in course of development, the cell-sap separates into the interior. At this time also in the denser protoplasm, *vacuoles* or small cavities arise, which are separated from one another by bars of protoplasm, broadest at first, and are filled with the fluid sap. Where the nucleus is in the centre of the cell part of the protoplasm collects round it, while another portion is retracted to the inner surface of the membrane, the two being connected by the bars or finer threads of protoplasm, which

pass through the cell sap. When the cell nucleus is embedded in the wall-plasma, then the separate vacuoles unite into a single central vacuole, which becomes the whole inner cavity of the cell occupied by the cell sap, and only in rare cases a few fine protoplasm threads stretch across from wall to wall. In the very young first-formed cell the protoplasm appears quite uniform, and as a finely granulose semi-fluid. The next stage is a separation into two layers, one, almost quite homogeneous and viscid, lies close to the primordial membrane; the other, more fluid and granulose, stands between the outer layer and the central fluid. This inner is named by Pringsheim the granular layer, and is usually more abundant than the outer layer; in it also lie the nucleus, chlorophyl, &c.

One of the most interesting phenomena of cell life is the movement of the granular protoplasm, observable in all young living cells, and this, moreover, takes place in two directions. We may detect—1st, a *parietal* current where the stream follows the outline of the cell wall, either simply ascending and descending, or crossing spirally, or branching in a net-like form; 2nd, an *internal* current, which extends along the protoplasm threads, crossing the *lumen*, or clear central space of the cell.

The simple parietal current is exemplified by the well-known cyclosis or circulation in *Nitella* and *Vallisneria*, and is also well seen in the hair-like radicles of the *Hydrocharis morsus ranæ*, or Frogbit, and less readily in *Naias*, *Closterium*, &c.

A single spiral parietal current may be observed in the hairs from the ovary of various species of *Œnothera*, and in elongated cells from the young flower-stalk of *Tradescantia Virginica*, and also in young cells of jointed hairs from stamens of the latter plant. More complicated spirals are well seen in the young elaters of liver-mosses. A reticulate, branching current can only be observed at the commencement of similar formed thickening layers of vessels and cells.

The internal current passes to and from the cell nucleus; a variable number of simple or anastomosing streamlets of granular stratified protoplasm run across on the inner side of the cell wall, or through the lumen of the cell, returning immediately to the nucleus, and after repeated gyrations, uniting with the protoplasm enclosing it. This phenomenon may be observed in every young, recently-impregnated germ-cell, in the commencing cells of paren-

chymatous tissue, and in general in all young cells in a state of active growth, in which the parietal current is not observable. The internal circulation commences at the time when the protoplasm and cell-sap separate, and vacuolation commences in the former, and although probably existing in the youngest condition of the cell, it is only when the granules become developed that we can distinguish it. The jointed staminal hairs of *Tradescantia* are well adapted to observe the gradual formation of the internal current; by selecting young flower buds of various ages we may find hair-cells in every stage of progress, and a corresponding development of protoplasm, but a warm sunny day is requisite to exhibit the movements to advantage. The cause of these movements appears to depend on vital chemical action, and is without doubt intimately connected with the process of nutrition. The chemical reactions of protoplasm are the same as those of the primary cell membrane, showing that it belongs to the albuminous class of bodies; the outer homogeneous layer, is, however, less deeply coloured.

The Cell Sap is a watery fluid, containing various organic and inorganic compounds in solution, such as sugar, gum, dextrine, tannin, colouring matters, &c.

Formed Organic Contents of Cells.

Having thus glanced at the anatomy of the plant cell in its active living state, we may refer briefly to a few other matters found in cells, resulting from vegetative action, and there stored up for future use in the economy of the plant or as effete material. The chief of these are Starch, Inulin, Chlorophyl, Aleuron, Crystals and certain colouring matter.

Starch is most widely diffused through the whole vegetable kingdom, and is of vast importance from the part it plays in the food supply of the whole world.

Starch occurs almost entirely in parenchymatous cells, and in many tissues at all times of the year, while in others it is found only during the period of rest, being dissolved and consumed in the process of renewed growth, *e.g.*, in the potato, which we plant in spring a heavy solid tuber, and turn up again in autumn a light, empty skin.

In size the starch granules vary considerably, both in different plants and according to their age in the same plant, the limits being about ·001 and ·2 mm. in diameter. Their form is also

variable; and this. with the position of the nucleus and degree of lamination, afford distinctions for recognising particular kinds of starch. We may distinguish simple and compound starch granules, the former being most frequent, and divisible into *rounded*, as in the starch of Potatoe, Canna, Gramineæ, Leguminosæ, &c.; *flatly orbicular* in Turmeric and other Zingiberaceæ; *rod-shaped* in the milky sap of Euphorbias. The compound starch granule usually forms the segment of a sphere, and is met with in *Allium* and *Colchicum*, in the root-bark of Sarsaparilla, and in Bryony root. Each starch granule consists of starch substance, water, and a minute quantity of mineral matter; the former is a carbo-hydrate, agreeing closely with cellulose, and appears in the granule under two modifications, one more soluble, which with aqueous Sol. of Iodine, assumes a fine blue colour *(Granulose)*; the other but little soloble, and in reaction coming nearer to cellulose (*Starch-cellulose*). If the granulose be removed the cellulose is left behind as a skeleton of the granule, but its weight is only 2—6 per cent. of the whole.

The true structure of the starch granule has been a subject of much dispute. The view long held was, that growth arose by apposition of homogeneous laminæ, deposited over each other from within outward, the dark striæ being due to interspaces containing air, and the refraction of light by the edges of the laminæ. We observe within the starch granule a centric or excentric nucleus, erroneously called a hilum, and around this the laminæ are deposited. Now, Nägeli, in an elaborate paper on the subject, states that growth occurs only by intus-susception, and that the appearance depends on adjacent laminæ, which are alternately rich in water and anhydrous. The layers increase in thickness and size by internal deposit, then a differentiation is set up, and if it be a dense layer a matter rich in water is deposited in its median plane, and it now becomes split into two lamellæ. Often two nuclei are found in a young granule, round each of which lamellation takes place, and growth being strongest in the line connecting them, the nuclei constantly move further apart, until an internal splitting at right angles to the connecting line leads to the formation of two granules. If this dividing be oft repeated, highly compound granules result, as in the endosperm of Oat and Spinach, also in the parenchyma of quick-growing plants, as melon-stems and sprouting plants of kidney-beans, in which they are mulberry-shaped.

INULIN.—This is only found in the compositæ, and most frequently in the roots, as in *Inulæ Helenium*, or Elecampane, *Helianthus tuberosus*, or Girasole Artichoke, Dahlia, Dandelion, &c. In living cells, it only occurs in solution; but in dead cells, or after drying, it appears in small granules. It is best observed by soaking a lump of the root a week or two in alcohol or glycerine, and then, examining a section, the globules are seen to be single or grouped into spherical or hemispherical bodies, often adhering to the cell wall, and traversed by radially divergent cracks; and after stay in acid, also showing concentric ones. Iodine colours Inulin yellow, and, like starch, it exhibits a black cross by polarized light.

ALEURON was discovered by Hartig, in 1855, and occurs in the oily seeds of Leguminosæ free from starch, in castor oil seeds, the Hazel-nut and Brazil-nut, as well as associated with starch in the albuminous seeds of Conifers as *Pinus Cembra*. It is in round or elliptic granules, like those of starch, without laminæ, and is readily soluble, its reactions shewing that it belongs to the albuminous group.

CRYSTALLOIDS.—These resemble crystals in form, but they are of the nature of protein. Hartig and Masche detected them as a nucleus in Aleuron-granules, the latter regarding them as casein. They are found in the Potatoe as small cubes imbedded in protoplasm near the nucleus, and Radlkofer detected them in the nucleus of the cells of Lathræa squamaria; in the pulp of the fruit of Solanum Americanum, they occur in clusters of violet-coloured rhombic plates. Sol-Iodine colours them fine yellow, Millon's test (nitrate of mercury) deep red.

CHLOROPHYL.—The green colouring matter of leaves is widely diffused throughout the vegetable kingdom, and is not contained in Vesicles, but separates from the protoplasm in amorphous granules, or it is deposited around some of the cell-contents, for by the application of alcohol or ether, the chlorophyl is dissolved out, and the substratum is left. *Draparnaldia*, *Closterium*, and other Algæ, and also cells of *Anthoceros*, contain amorphous chlorophyl, invested by the general protoplasm of the cell; but it is almost always found covering grain-like formations, and the condition is familiarly known as chlorophyl granules. The substratum of these is of two kinds; 1st, it is formed of a nitrogenous substance, probably hardened protoplasm, which, after removal of the chlorophyl,

is left behind in lenticularly flattened granules, ·0075—·009 mm. in diameter; such are found in the full-formed leaves of Tulip, Holly, *Sedum acre*, &c. 2nd, the substratum on which chlorophyl is deposited, consists of one or more starch granules of various forms, and this kind alone is found in the leaves of mosses and Hepaticæ, and the leaves of Mistletoe and *Hoya carnosa*.

To return to the origin of chlorophyl, it is clear this must be observed in the earliest development of germinating plants. We find that the first kind of chlorophyl granules proceeds from colourless protoplasm, either homogeneous, or with very fine molecules, and while it is acquiring a yellow-green colour it is formed into small spherical masses, which later become overlaid by the entirely green colouring matter. In the second kind the starch granules appear after the chlorophyl granule is formed.

The origin of starch in chlorophyl is as follows:—In the perfect chlorophyl grain, there appear within the homogeneous mass one or more granules, which gradually enlarge and distend the grain, so that the enveloping green layer thins away, and at last disappears, and the free starch granule becomes visible. When the chlorophyl grain contains several starch granules, as these increase in size, they become flattened on the sides touching each other, and thus acquire polyhedral facets, while the free outer surface remains spherical. It is needless to add that extremely fine sections, and high magnifying power are requisite for these observations.

Colouring Matters.—These occur as evident cell contents, either dissolved in the cell sap, or, like chlorophyl, collected in a granular protoplasmic form; the pure blues and red as a rule occur in the former state, the yellows in the latter. Wigand believes that the blue and red matters (Anthocyan) owe their origin to Tannin, the yellow (Anthoxanthin) to Chlorophyl.

Crystals.—The crystals appearing as cell-contents are usually oxalate of lime; but tartrates and citrates are also met with. Crystals only occur in parenchymatous tissues, and are found in almost all flowering plants, in Fungi and crustaceous Lichens, but not in Algæ, Mosses, or Ferns.

The crystals may be single, or in pairs, as in *Begonia*, and in germinating plants of *Phaseolus*; more frequently they occur in groups of numerous crystals (Sphœraphides of Gulliver), which are usually deposited round a nucleus of organic matter, as in Rhubarb, Hoya, the leaf of Begonia, and stem of the India-rubber plant.

In Monocotyledons, especially Liliaceæ, Araceæ, and also in Cactaceæ, the crystals are in form of long needles, termed Raphides, which lie parallel in bundles, and often fill the elongated cells, especially in autumn, though during active growth they may be entirely absent. In the Fungi and Lichens, the crystals are usually very small, and not enclosed in cells, but collected outside the cell-wall. In the walls of thick fusiform cells (Spicular cells) of the curious plant *Welwitchia mirabilis*, Dr. Hooker detected numerous scattered rhombic crystals, and Millardet found similar crystals in the bast-cells of the bark of *Acer pseudoplatanus*.

In active protoplasm currents sometimes occur small crystals, as in hairs of the cucumber plant, where they are octohædral. These usually occupy the cell lumen, and are enclosed in a very thin envelope, which is probably the true condition in all cases. Carbonate of lime has been found by De Bary, as distinct crystals in Physareæ, and as little nodules or cystoliths in certain cells of species of Urtica, Ficus, and Acanthaceæ. In still finer division and entering into the structure of the commissures of the cell-walls, carbonate of lime is found in many Algæ, as the species of *Corallina*, *Jania*, and *Melobesia*, which on this account are highly fragile, and of stony consistence.

ILLUSTRATIVE FIGURES AFTER SACHS.

Plate 6.

Fig. 1.—Young Pollen cell × 670. A, invested by the membrane only. B, after the cellulose case has formed. C, ditto, after treatment with Sol. Iodine, —*n.* nucleus, *c.* cellulose case, *s.* primordial utricle, *p.* protoplasm.

Fig. 2.—Parenchymatous cell of flower stalk of Tradescantia Virginica, with a simple spiral parietal current of protoplasm; *n.* nucleus, *p.* protoplasm, *cl.* chlorophyl. × 420.

Fig. 3.—Cell of staminal hair of same, showing internal currents. × 660.

Fig. 4.—Cells from stem of germinating onion; *a.* the yellow protoplasm invests the central nucleus, and sends filaments toward the wall; *b.* an older stage, the nucleus applied to the wall, fine threads of colourless protoplasm, chlorophyl fully formed, and lining the wall.

Fig. 5.—Starch granules × 660. A. from Turmeric. B. from stem of Sarsaparilla. C. from milky sap of Euphorbia splendens.

Fig. 6.—Very thin section of cotyledon of Pea, showing starch granules in section. × 800.

Fig. 7.—Two cells of Dahlia root treated with alcohol, and showing Inulin; *a.* in water, *b.* after application of nitric acid. × 420.

Fig. 8.—Crystals × 320. *a.* single octohedron from leaf of Begonia heracleifolia; *b.* crystal cluster from the same; *c.* cell with raphides from stem of Aloe retusa.

The Potato Disease.

Translated from Professor de Bary's Monograph of Peronospora in "Annales des Sciences Naturelles."

It is known that the epidemic disease of the potato which has appeared in Europe since 1842, and particularly in 1845, is traced to the presence of *Peronospora infestans*, a species that was discovered by Mdme. Libert, and by Montagne. Many authors have treated this malady from different points of view, and it is particularly the relations of the parasite with the disease that have been the object of numerous discussions and controversies. In a work treating of *Peronospora* this important subject cannot be passed in silence. The various opinions that have been held upon this subject are so generally known, that it would be useless to give a detailed exposition here. I shall limit myself, then, to a resumé, and a criticism that supports itself directly upon observation.

The opinions classify themselves in two opposite groups. *One* sees the cause of the epidemic in the diseased state of the potato itself, produced either accidentally by unfavourable conditions of soil and atmosphere, or by a depravation that the plant has experienced in its culture. According to these opinions, the vegetation of the parasite would be purely accidental, the disease would be independent of it, the parasite would be able frequently even to spare the diseased organs.

The *others* see in the vegetation of the *Peronospora* the immediate or indirect cause of the various symptoms of the disease; either that the parasite invades the stalks of the potato, and in destroying them, or, so to speak, in poisoning them, determines a diseased state of the tubers; or that it introduces itself into all the organs of the plant, and that its vegetation is the immediate cause of all the symptoms of the disease that one meets with in any organ whatever.

The observations rigorously prove that the opinions of the second group, expressed especially by M. Payen, Montagne, Tulasne, Berkeley, &c., are the only well founded. I can only confirm the theory that one owes to the happy experiments of Dr. Speer-

schneider, a theory that has been proved by a series of observations recently published in a German brochure (De Bary, Kartoffel, &c.), according to this theory the symptoms of the disease would be always produced immediately by the invasion of the parasite.

It is necessary to recollect that the epidemic of which we speak is characterised by symptoms clearly noted; that it is not a question of any malady whatever, but of a single disease quite special. This malady ordinarily appears in the middle or towards the end of the summer by spots of a blackish-brown, that appear upon the haulms and fruits of the potato. The organs fade, take entirely the signalised colour, and at last they dry up and rot. The plants thus destroyed can bear healthy tubers, but it is too frequent that these are altered in a particular manner. Their surface offers wrinkled depressions of a variable disposition and extent. In cutting the tubers, one sees the parenchyma that touches the skin of the depressed parts coloured of a dark brown to a depth of some millemetres. The brown tissue appears to be more dry and more compact than the normal parenchyma. When the malady has made some progress the brown discolouration extends itself upon the entire peripheric parenchyma, and here and there to a more considerable depth, the entire surface of the tuber becomes wrinkled, and of a dirty-brown colour. The parenchyma of the interior of the tuber remains at first healthy and normal, but it finishes by undergoing either the dry or wet rottenness, and the tuber is covered with mouldiness, many times described. When one sows the spores of *Peronospora infestans* upon the heathy leaves of the potato, in taking the precautions already indicated, the germs enter through the epidermis, the mycelium expands itself in the tissue of the sown spot, and, at the end of a few days, there produces fruit. The tissue invaded by the parasite preserves at first its greyish green, later it becomes a little yellowish; when the conidia have attained their maturity, the tissue becomes of a dirty-green, softens, then takes a blackish colour, and either dries up or rots. The blackish spot is thus formed. The tubes of the mycelium, that are contained there, die with the indicated alteration of the parenchyma; but those that, in the periphery of the spot, touch the healthy parenchyma, extend themselves in it, to make it undergo the same alterations as those just described. It is thus that the mycelium takes a centrifugal development, and that this development determines a similar extension of the black spots. When one examines the haulms taken from any field whatever, one always finds the

same development of the parasite, and the same extension of the spots. The mycelium always occupies at first the green and healthy tissue, that, the fructification of the parasite being finished, becomes softened and browned. One cannot, then, doubt that the spots of the leaves may not be produced by the parasite that has entered them. And as to the rapid propagation of the disease, it explains itself by the great quantity of sporangia that the parasite produces, and by the rapidity of its development. We must remember that the reproductive organs of *Peronospora* are already abundantly developed when we observe in a field the first traces of the disease. It is true that, according to the facts already explained, the sporangia and the spores of the parasite require water to take their normal development, but the results of the experiments accord very well with what is observed in the cultivation on a large scale, where the progress of the disease is always more rapid when the weather and the aspect of the field are more favourably situated for the aqueous precipitations of the atmosphere, whilst drought arrests the development of the parasite, and the progress of the disease. The appearance of the fungus on the fruit of the potato and allied plants, especially the tomato, has been known for a long time, and it is known that similar alterations are there produced to what occurs upon the leaves.

As to the brown spots that are found upon the stalks and the petioles of the diseased haulms, it has often been denied that the parasite is found there, because one finds but rarely the fruit at the surface. Nevertheless, it is always enclosed. The mycelium that crawls among the cellules of the compact tissue is always difficult to meet with. The intercellulary passages appear to be filled with granular matter, that nevertheless, in good preparations, show the proper membrane of the tubes of the mycelium. Their nature can be placed beyond doubt when the spots are strongly moistened. The doubtful tubes can then be seen shooting out their branches; these perforate the cellules, elevate themselves to the surface, and there engender the normal fruit of *Peronospora*. Besides, one can easily obtain the same results that are observed in the spontaneous state, in sowing the parasite upon the stalks of the potatoe; it is by this sowing that the alterations of the tissue are directly determined by the vegetation of the endophyte. In the altered tissues of the leaves it is principally the contents of the cellules of the parenchyma that undergo the discoloration; the membranes take

the brown colour less deeply, often they remain colourless; the walls of the epidermis alone present a deep colour. ' These, then, are the parts that the parasite does not immediately touch that offer the most perceptible alterations. The cortical and epidermic cellules of the stalk are in great part filled with a watery liquor containing but few granules, and upon the brown spots it is particularly the membrane that present the deep colour. But, in observing the penetration of the germs, and the progress of the mycelium in these parts, one often sees that the coloration of the membrane commences at the point that is first touched by the tube of the parasite. Parting from this point, the brown colour extends itself little by little around the rest of the touched wall, and spreads itself successively upon the most distant cellules, which have no contact with the *Peronospora.* One thus sees that the parasite alters the point that it first immediately touches, and that the alteration propagates itself upon the perfect elements of the tissue. It is thus that the brown coloration often extends itself to a distance of some centimetres, either in the superficial parenchyma or in the vascular bundles.

In the tubers the wrinkled and brown parts that characterize the disease are always occupied by the *Peronospora.* I will not repeat here the numerous descriptions that we possess of the structure, and of the alterations of these parts. I will only add the fact that the mycelium always creeps along the brown cells. It has been already seen, without doubt, by Martius,* who, in describing the diseased tissue, makes mention of intercellulary passages filled with granular matter. In examining attentively the tissue in question, one can easily find these pretended passages, but at the same time one can convince oneself that these are the ordinary tubes of the mycelium, furnished by a proper membrane, often thickened, making themselves passages amongst the cellules of the parenchyma. It is not always easy to find or follow these tubes, because the brown tissue is too opaque for one to well observe them in the microscope in thin slices, and because in these very thin slices the tubes are frequently cut, and are in consequence little visible. There is, nevertheless, a means of convincing oneself of the presence of the mycelium, and of proving rigorously, at the same time, that the intercellulary tubes belong in reality to the *Peronospora.* When a diseased tuber is cut and shielded from dessica-

* "Die Kartoffel-epidemie," by Dr. Fr. P. V. Martius, Munich, 1847.

tion the surface of the slice covers itself with the mycelium and conidiiferous branches of *Peronospora infestans*, and it can easily be proved that these organs derive their origin from the intercellulary tubes of the brown tissue. The mycelium that is developed upon these slices is ordinarily very vigorous; it often constitutes a cottony mass of a thickness of many millemetres, and it gives out conidiiferous branches, often septate, and larger and more branched than those observed on the leaves of the potato. The appearance of these fertile branches ordinarily takes place at the end of from twenty-four to forty-eight hours; sometimes, nevertheless, one must wait for many days. These phenomena are observed in all the diseased tubers, without exception, so long as they have not succumbed to putrefaction, which arrests the development of the parasite and kills it.

One can easily imagine, after what has been said, that the *Peronospora* immediately determines the disease of the tubers, as well as that of the leaves, and this supposition is perfectly proved by experiment. When one sows *Peronospora* upon a healthy tuber one sees the germs of the parasite penetrate into the superficial cellules, spread itself in the peripheric parenchyma, and produce the same alterations which are observed upon the tubers taken from the field. It is indifferent whether the tuber experimented upon be cut or entire, exposed to the air, or placed in a humid soil; the parasite ordinarily only fructifies upon the cut surfaces. In the parts of the tuber that are protected by the skin the mycelium remains sterile, or at least, only fructifies when a potato furnished with a thin, fine skin, is exposed to excessive humidity; a condition which increases the vegetation of the parasite.

How can the mycelium of the parasite reach the tubers in the ordinary culture of the potato? There is no doubt that that takes place by the aid of sporangia. When healthy tubers are placed in the earth, at a depth of from one to two centimetres, and when one sows the conidia of *Peronospora* on the surface of the earth, watered from time to time, one sees at the end of from eight to ten days the tubers attacked by the disease. This commences in the tuber on the side turned towards the soil. It offers all the symptoms that have just been explained. It is not necessary in these experiments to wet the earth excessively; a moderate watering suffices. When the earth that serves for the experiment is examined, or the soil of a field of which the leaves are invaded by the *Peronospora*,

the conidia are easily found at a considerable depth. These facts prove, then, that the conidia are carried to the tubers by the water which penetrates the soil, that this liquid determines the development of the spores, and the germs in the soil even, and that these invade the tubers, there to produce the known alterations.

One can thus suppose that the mycelium enclosed in the leaves can arrive in the tubers in descending through the tissues of the stalk. This is a supposition which appears to me possible enough, but which I have not been able exactly to verify. If it be thus, there will be a second way by which the parasite can reach the tubers. However it may be, the first way, of which the existence is directly proved, appears to me perfectly to explain the phenomena in question.

One will easily understand, by what has been stated, why frequently the leaves of a field are entirely destroyed by the parasite, while the greater part of the tubers remain unhealthy. However great the number of the conidia fallen upon the soil may be, they cannot penetrate when there is no water to carry them down ; they can encounter on their way numerous difficulties, at last they can reach the tubers without the quantity of water contained in the soil being sufficient to determine the development, and introduction of the germs. The want of water can equally arrest the growth of the mycelium if this were capable of descending through the stalks into the tubers. The observation mentioned is not then in contradiction to the theory advanced, but quite the contrary, I believe that it receives its explanation by it. It is the same, it appears to me, for all the observations that have been made in the culture on a large scale, and I dare say that these observations will necessarily agree with a theory that is founded upon conclusive experiments.

I remind the reader here that the first appearance of the parasite in the season of cultivation has been explained in one of the preceeding paragraphs by the faculty that the mycelium contained in the diseased tubers possesses of conserving its life during the winter. Indeed, potatoes are frequently found of which one part of the parenchyma is infested by the *Peronospora*, while the rest remains healthy so long as the tubers are preserved in a dry place. It is by such tubers that the parasite is preserved, and probably by this means was introduced into this country.

As regards the Mucedines that infest the diseased potatoes,

such as the *Fusisporium Solani (Spicaria solani)*, so often described, these are moulds which are nourished by diseased tissue, and do not affect the healthy tubers ; it can be easily verified that their vegetation is of no force, or very tardy, upon the normal tissue, and that it never determines a symptom of the disease which now occupies us.

The vegetation of the *Peronospora*, then, alone determines the redoubtable epidemic to which the potato is exposed. Is the invasion of the parasite favoured by any predisposition whatever of the affected plant? It is said that the different varieties of the potato are not equally exposed to the malady. I will not deny that assertion, without however being able to confirm it. There are certainly some doubts on the subject, because frequently assertions advanced on the same variety contradict each other. Nevertheless, in admitting different predispositions in different varieties, one ought to arrange them among the specific predispositions of which we have already spoken, the existence of which cannot be contested. As to the individual and unhealthy predisposition that we have indicated so frequently, it must be first remarked that nearly all the authors that admit it have positively ignored or denied the determining influence of the parasite, and it is upon this last point that their opinions are supported. After what is known, and has been proved, these opinions are of little value. And I deny that the introduction of the parasite is favoured by any predisposition of the affected plant, either of the potato or any other kind whatever. Experiments at least show nothing in support.

The parasite being sown with the necessary precautions upon a morsel of healthy tuber, this becomes diseased, while the rest of the tuber preserves its normal condition. In making similar experiments upon the leaves analogous results are obtained. Comparative experiments upon a quantity of plants of the same variety have always given me the same results; nothing determines the invasion of the parasite except the careful sowing of the conidia. The plants experimented upon *always* became diseased when treated with conditions indispensable to the vegetation and propagation of the parasite ; while those protected from the influence of the conidia remained healthy. In very numerous experiments I have never found that one individual was more favourable to receive the parasite than another, provided that the cultivation was carried on under equal external conditions.

PROCEEDINGS.

13th December, 1872.—Conversational Meeting.

New forms of Hippuric Acid crystallised over Sulphurous Acid	Mr. T. C. White.
Section of Blow-fly ... ... Chelifer (alive) ... ... Spiracle of a larva (unknown)	Mr. Fitch.
Marine Diatomaceæ	Mr. J. G. Waller.
Larva of Ephemeris, alive and polarised ...	Mr. Burch.
Spicules of Gorgonia and Astromma (pentagonal form)	Dr. Matthews.
Spiracles of various larvæ	Dr. Ramsbotham.
Micro-fungi	Mr. Golding.
Asparagine	Mr. Ward.
Aulacodiscus (various sp.)	Mr. Hailes.
Pleurosigma formosum (1/5th obj., dark ground)	Mr. G. Williams.
Sections of Coal, containing a new and unnamed species of Calamite, &c. Seeds of Calamite with axis of Lepidostrobus	Mr. Daintrey.

December 27th, 1872.—*Chairman*, Dr. R. Braithwaite, F.L.S., &c., President.

The following donations to the Club were announced:—

"The Monthly Microscopical Journal" ...	from the Publisher.
"Science Gossip"	the Publisher.
"Proceedings of the Royal Society," Nos. 138 and 139	the Society.
"The American Naturalist"	in exchange.
"Proceedings of the Liverpool Natural History and Philosophical Society"	the Society.
Paper "On New British Graptolites" ...	Mr. John Hopkinson.
Three Weather Maps	Brigadier Genl. Myer, Chief Signal Officer U.S. Army.
Six Slides...	Mr. Jas. Watkins.

The thanks of the Club were unanimously voted to the donors.

The following gentlemen were ballotted for, and unanimously elected members of the Club:—Mr. Herbert Barnard, Mr. William K. Bridgeman, and Mr. Charles E. White.

Mr. Wm. Webb read a paper "On the Best, the most Simple, and Unerring Tests for Objectives." (The paper was published in the "Journal" of the Q.M.C. for January, 1873.)

The President having expressed the pleasure with which he had listened to the reading of the paper, and his sense of the indebtedness of the Club to Mr. Webb for bringing the subject before them, invited discussion upon the points which had been touched upon.

Mr. Ingpen said he was sure that the members of the Club would welcome a new test, though their criticism was at present disarmed, as they had not yet had an opportunity of examining the objects which had been described, so as to enable them to judge of their value as tests. Until they could do this, he thought, they would have to fall back upon old tests, such as the Podura scale and the P. angulatum; for although we did not perhaps quite understand their structure, we did know what errors they would test, and how a good objective should shew them. There was much difference of opinion as to the value of Nobert's lines as tests, and he should be glad to have Mr. Webb's opinion, and to learn his method of using them for that purpose. The value of the test objects in common use consisted chiefly in the extreme regularity of their markings, in form and arrangement, and it seemed to him that such irregular objects as letters or words, or isolated dots of carbon, however small they might be, could not possess an equal value. He referred to Mr. Slack's experiments with colloid silica,* as shewing the illusive appearances presented by irregular fissures in a transparent substance. Mr. Webb had certainly introduced a new unit of measurement—so many Bibles to the square inch—which might be useful, though he (Mr. Ingpen) did not like the use of square measure. The smallest specimen was on the scale of 15 Bibles to the square inch, and he only remembered this minuteness to have been surpassed in the case of the Lord's Prayer written with the Peter's machine on the scale of 22 Bibles to the square inch, as mentioned in the President's address to the Microscopical Society in 1862. Lines ruled on glass have for many years been used as a test for flatness of field. We were apt to forget old methods of testing, and it was well that we should be reminded of them. Part of the distortion referred to by Mr. Webb was due to the construction of the Huyghenian eyepiece, and exists when the spherical aberration of the object-glass has been well corrected and compensated. If this were not done, the lines of a stage micrometer would not be in focus at the edges of the field; but when corrected, and the lines all fairly in focus over the whole field, the line forming a diameter of the field would appear straight, but the others, though really straight and parallel to it, would appear to curve outwards, the curve increasing as the lines approached the edges of the field, the spaces between them also increasing in equal proportion. This was the case with all Huyghenian eyepieces, however well constructed, and this was the reason why they could not be used for astronomical measurements, as they did not give equal areas throughout the field, and a Ramsden positive eyepiece was used for that purpose, the objection to which was that it gave a highly coloured image. Mr. Browning had, he believed, made a positive achromatic eyepiece which met both difficulties. To test an objective for flatness of field a

* "Monthly Microscopical Journal," January 1, 1871, p. 14.

positive eyepiece would be best. He thought that these miniatures of the Lord's Prayer would be welcomed as additions to what might be called "toy slides."

Mr. T. C. White said he thought that it was to be regretted that they had not the opportunity of seeing some of these wonderful specimens of microscopical writing. He had brought with him a specimen of Mr. Webb's writing, but he feared, however, that it was very imperfect as a test. It seemed to him that if they had a number of lines, and these were not blackened in any way, that would they become so distorted by reflection and interference of light, that it would seriously interfere with their definition.

Mr. Webb having intimated here that he had specimens with him, Mr. White offered to place his microscope at that gentleman's disposal for the purpose of exhibiting them.

The President said he was under a disadvantage, not having had the opportunity of studying the subject, and he therefore felt utterly incapable of forming an opinion on it; he could not, however, help expressing his admiration at the manner in which Mr. Webb had thus worked on with such untiring ingenuity. Although Mr. Ingpen thought that these slides were not of much value as tests, yet from their extraordinary minuteness he could not think they were altogether to be disregarded. He regretted that Mr. Webb had not told them anything as to the means by which he had accomplished such surprisingly small specimens of writing.

Mr. Webb said he thought the process would have been too well known to require any reference—the machine was exhibited in the Exhibition, and members used to go and write their names with it there. He was glad to find that Mr. Ingpen had been kind enough to criticise his paper, because it was only by some sort of objection that information upon many points could be obtained. Mr. Ingpen alleged that the distortion was not due to the objective but to the eyepiece; he would ask that gentleman if he had ever tried to use the Huyghenian eyepiece without the field lens? If so he would have found that the distortion was doubled, and it would be clear from this that the distortion was not due to the eyepiece but to the object-glass itself. The fact was, really, that the distortion of the object-glass was reduced and corrected by the eyepiece if it was made by a good maker. As to the specimen mentioned as having been written by Mr. Farrants in 1862, it was announced in his presence, and it was then stated that if the tail of the y was left out, the breadth of the line measured the $\frac{1}{365000}$ inch, or at the rate of 22 Bibles to the inch. He did not doubt Mr. Farrants' word in the matter, but he could only say he never saw the specimen; and although both he and others had asked Mr. Farrants to show it to them, they never could get a sight of it. He remembered that Mr. Farrants stated on one occasion that it was only by a piece of luck that he happened to have a diamond that would do it. At the Exhibition of 1862 the only specimen which was exhibited by Mr. Farrants was the $\frac{1}{40000}$ inch, and this was shown under one of Messrs. Smith and Becks' $\frac{1}{4}$ inch objectives with a B eyepiece. As to the value of these slides as tests, that remained a question for the members themselves—it was only for him to suggest their usefulness in that way; it was whilst talking upon the subject to a gentleman (present that evening) that it had occurred to him that it might be useful if he gave them some of the results of his experience. It was only by rubbing two dry sticks together that they got a spark, and so it was only by such discussions that they obtained much useful information. Mr. Ingpen had mentioned Nobert's tests, and said there

was some uncertainty about them. He hoped on another occasion to give them a paper upon this subject.

Some further discussion then took place between Mr. Ingpen and Mr. Webb as to the cause of the distortion alluded to, each gentleman maintaining his own view, and illustrating the same by illustrations on the black board, and Mr. Webb finally suggesting that if the eyepiece were removed altogether and a film of collodion substituted, the distortion of the object-glass would then be seen increased tenfold.

Mr. Hainworth supposed that a great deal would depend upon the flatness of the glass upon which the tests were engraved.

Mr. Webb said he used glass ·003, and the spot upon which he engraved was itself so small that he could not conceive of its being otherwise than flat; at any rate the diamond would penetrate to the same depth only throughout, so that the letters themselves would be uniformly flat.

Mr. Curteis expressed a hope that Mr. Webb would give them his opinions upon Nobert's tests upon some future occasion.

The President having also expressed a hope that Mr. Webb would do so, proposed a vote of thanks for the paper, which was carried unanimously.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Sections of Orange Peel ... ... ,, Cabbage Leaf Stalk ...	by Mr. Burch.
Hairs of *Tiresius serra*	Mr. Curteis.
Micrometer upon Dr. Piggot's principle ...	Mr. Ingpen.
Coccus Aurantii	Mr. Jas. Smith.
Parasitic Moss	Mr. J. G. Waller.
Specimens of Microscopic Writing	Mr. Wm. Webb.
Skin of Negro	Mr. T. C. White.
Circulation in Water Louse (polarised) ...	Mr. Geo. Williams.

Attendance—Members, 46; visitors, 8.

January 10th, 1873.—Conversational Meeting.

Sections of Blow-fly	Mr. Fitch.
Eye of Lobster (section)	Mr. E. T. Newton.
Section of Horse's hoof	Mr. Sigsworth.
Sections of retina of Frog's eye ... ... Peptic glands of proventriculus of Pigeon ...	Mr. Slade.
Desmidiaceæ *(Closterium)*	G. Williams.
Spiral vessels of Rhubarb and other objects, mounted in a new medium	Mr. Oxley.
Rectal papillæ of *Pulex irritans*...	Mr. T. C. White.
Lepisma saccharina (alive)	Mr. Golding.
Mosses, &c., polarised	Mr. Burch.
Sections of foot of Fœtus (6 months), and 7 other Fœtal sections	Mr. Daintrey.
Chelifer	Mr. J. W. Goódinge.

Members, 50; Visitors, 9.

JANUARY 24TH, 1873.—*Chairman*, DR. R. BRAITHWAITE, F.L.S., President.

The following Donations to the Club were announced:—

"The Monthly Microscopical Journal" ...	from	the Publisher.
"Science Gossip"	,,	,,
"The Popular Science Review"	,,	,,
"Proceedings of the Royal Society," No. 140	,,	the Society.
"The Lens"		in exchange.
"The American Naturalist"		,,
3 Copies of "The tri-daily Bulletin," issued from the Chief Signal Office," Washington	,,	Brigadier Gen. A. J. Myer.
19th Annual Report of the Brighton and Sussex Natural History Society, and a catalogue of the books in its Library...	,,	the Society.
A paper "On certain Wingless Insects," by Mr. T. W. Wonfor	,,	the Author.
2 Slides—Crystals obtained from the vapour of coke	,,	Mr. Alfd. Allen.
24 Slides	,,	Mr. James Watkins.

The thanks of the Club were unanimously voted to the donors.

The following gentlemen were ballotted for and unanimously elected members of the Club:—Mr. Francis Joseph McBride, Mr. James T. Powell.

Dr. Braithwaite having requested Dr. Matthews to occupy the chair, read a highly interesting paper upon "The Histology of the Plant Cell," being the first of a series of papers upon Plant Organisation.

Dr. Matthews proposed a vote of thanks to the President for his very admirable paper, which he felt sure all present must have highly appreciated. The vote was carried by acclamation.

Mr. T. C. White, in thanking Dr. Braithwaite personally for his elaborate paper, said it was, as its author had observed, but a skeleton of the entire subject, each part of which would be most interesting if worked out, the varieties of cell, Raphides, or Chlorophyl Granules would each form interesting studies. With regard to the latter, he hoped Dr. Braithwaite would be able to give them some information as to how they multiplied by self-division. He remembered to have seen this going on in all stages one evening, under one of Messrs. Powell and Lealand's beautiful $\frac{1}{16}$-inch immersion objectives; he should like to ask if this was the usual way of multiplying.

Dr. Braithwaite said that it was certainly unusual, although he thought it was very possible, that such a process might take place. He should be very pleased to see the Starch theory, to which he had alluded, further illustrated on some future occasion.

Mr. Charles Stewart inquired upon what grounds it was supposed that the starch granules really divided; he thought that the appearances would equally indicate the union of two cells.

Mr. White said that he had noticed them on the occasion named, in every condition; some were so nearly divided as to be quite of a dumb-bell shape.

The proceedings terminated with a conversazione, at which the following objects were exhibited :—

Wood Sections	by Mr. Burch.
Polarizing Crystals...	„ Mr. T. Curties.
Eggs of Parasite of Hornbill	„ Mr. Goodinge.
Section of Wasp's eye	„ Mr. S. J. McIntire.
Section of retina of Sheep	„ Mr. E. T. Newton.
Carbonate of Copper, &c....	„ Mr. Amos Topping.
Crystals distilled from vapour of Coke... ...	„ Mr. Watkins.

Also in illustration of the subject of Dr. Braithwaite's paper :—

Cells of Moss leaf (Atrichum undulatum), showing chlorophyl	by Mr. W. Hainworth.
Cells of Allium, after re-action of Chloro-iodide of Zinc	„ Mr. Goode.
Leaf of Allium, showing cells dyed by carmine	„ Mr. B. D. Jackson.
Starch cells from Potatoe, showing re-action of Iodine	„ Mr. J. A. Smith.

Present—Members, 93 ; Visitors, 18. Total, 111.

February 14th, 1873.—Conversational Meeting.

Section of Echinus spine, polarised	Mr. Geo. Williams.
Crystals in Water-glass (silicate of Potash) ...	Mr. F. Oxley.
Ophiocoma neglecta...	Mr. Goodinge.
Licmophora flabellata, in situ	Mr. Curteis.
Various injections	Mr. T. C. White.
Section of Ivy-stem	Mr. Burch.
Cuticle of Holly leaf ... ... Parasite of Bullfinch	Mr. Hawkins Johnson.
Cyclops, showing egg sacs	Mr. Martinelli.
Demonstration of injection	Mr. E. Bartlett.

A short lecture "On the Principal Arteries Concerned in Microscopical Injection," with directions for finding them. Mr. T. C. White.

Members, 59 ; Visitors, 7.

February 28th, 1873.—*Chairman*, Dr. R. Braithwaite, F.L.S., &c., President.

The following Donations to the Club were announced :—

"The Monthly Microscopical Journal" ...	from the Publisher.
"Science Gossip"	„ „
"Proceedings of the Geologists' Association"	the Association.
"Journal of the London Institution" ...	„ the Librarian.
"Proceedings of the Royal Society," No. 141...	„ the Society.
"Paper on a Hœmatozoon inhabiting human blood, and a report of Microscopical Researches into the nature of the agents producing Cholera ...	„ Dr. T. R. Lewis, of Calcutta.
"The American Naturalist"	in Exchange.
"The Proceedings of the Literary and Philosophical Society of Manchester	from the Society.

The thanks of the Club were voted to the donors.

The following gentlemen were ballotted for and duly elected members of the Club:—Mr. George Hy. Baker, Mr. Fredk. C. Barnett, Mr. A. W. Chapman, Mr. Alfred E. Haddon, Mr. J. W. Jenkins, Mr. George James Jones, Mr. Francis J. Kittsett, Mr. A. F. Mayhew, Mr. Charles Mills, Mr. William L. Smith, Mr. William A. B. Williams.

Mr. Ingpen said that he feared he had no improvements to bring forward, nor could he even promise anything new, but he thought that a gossip about eye-pieces might not be quite uninteresting or useless. The early history of the eye-piece was connected with that of the telescope, the invention of which was due to the discovery that the inverted diminished image formed in the focus of one lens could be magnified by another lens, and this principle was not applied to the microscope till long afterwards. The telescope and the microscope were, however, but modifications of the same instrument, and if an object-glass and eye-piece of equal foci were employed, a telescope or microscope of *no* magnifying power would result. This form was used in Martin's "Graphical Perspective:" a net-work of lines ruled in squares on talc was placed in the common focus of the lenses, and the objects shewn in each square copied on similar squares ruled on paper. There was also a "simple" telescope, where the eye, placed within the focus of the object-glass, became itself the eye-piece as in the simple microscope. This had been described by Dr. Dick. The early eyepieces were either single convex or concave lenses, the former being placed outside the focus of the object glass, the latter within the focus. In the first case a real image of the object was formed, which could be received upon a screen, and the eyepiece was called "positive," in the latter there was no real image, but the rays of light from the object glass were rendered parallel, and so received on the eye as an enlarged object. This was called a "negative" eyepiece. This term was afterwards applied to the Huygheman form, where the *real* image was formed between the lenses. The Huyghenian eyepiece was perhaps the most valuable accessory to optical science ever invented. Huyghens used it merely to distribute the spherical distortion between two lenses, and so flatten the field of view, but it was also found to correct the residual chromatic aberrations of the achromatic object glass, by delicate adjustment of the distance between the lenses. The field of view is nearly flat, but generally somewhat concave, so that parallel lines on a micrometer appear to diverge slightly from each other at the margin of the field, while lines forming a diameter appear straight. This effect varies according to the objective, the length of body, and the focal length of the observer's eye. and the field of view can be made concave, convex, or sensibly flat by careful adjustment of the distance between the lenses of the eyepiece. Various modifications of the Huyghenian eyepiece had from time to time been suggested and constructed. One of the earliest was the use of crossed lenses (*i.e.* double convex lenses of very unequal curvatures, generally 16) instead of plano-convex lenses. This arose partly from the difficulty of producing lenses with flat surfaces, particularly at the edges, and rendered the centreing easier. Then there was the form suggested by Professor Airy (Camb. Phil. Trans. III. i. 61), the field glass being meniscus (11.4), the eyeglass a crossed lens (1.6). Of other eyepieces used for the microscope the "Kellner" form with the focal lengths of the lenses in the proportion of 1.2. instead of 1.3. as in the Huyghenian, was often met with in Continental microscopes. In some of these the field lens was placed in the focus of the eye lens. These seemed to act pretty well with short bodies, but to be on

the whole inferior to the Huyghenian. There was another well-known "Kellner" eyepiece, with a meniscus achromatic eye lens and a double convex single field lens. The field was very large and flat and the definition fine, particularly for surface markings, but Mr Ingpen thought the great size of the field distressing to the eye. By using a diaphragm making a square or oblong field of view, this eyepiece became very useful in searching over crowded slides, as objects were often missed in the overlapping of circular fields. There was an excellent modification of this eyepiece by Horne and Thornthwaite, called by them the aplanatic eyepiece. There was another form constructed by Dr. Steinheil, in which the eye lens was double, consisting of two plano convex lenses with their convex surfaces towards each other. Various positive eyepieces were then described—the earliest, Ramsden's, still used for micrometers, the Rev. J. B. Reade's achromatic solid eyepiece, Browning's achromatic for reflecting telescopes, and others. Most of the eyepieces described were exhibited and their construction shewn by diagrams on the black board. Mr. Ingpen concluded by referring to the recent suggestion of Dr. Steinheil to use long bodies and low powered eyepieces (shewing an eyepiece suitable for that purpose), and by calling the attention of the members to the desirability of testing their eyepieces as well as their objectives.

The President proposed a cordial vote of thanks to Mr. Ingpen for his valuable communication. Carried unanimously.

Mr. Burr said that he believed he was the originator as well as the first possessor of the aplanatic eyepiece made by Horne and Thornthwaite. Having used a Kellner eyepiece for the microscope, he thought it would be very desirable to get one of similar construction made for his telescope, and having talked it over with Mr. Hislop and Mr. Ackland, the aplanatic eyepiece was the result, and he found its performance to be very satisfactory, as it took in a much larger field than usual without loss of light. The eyepiece was mentioned very favourably in the monthly notices of the Royal Astronomical Society, and it gave great satisfaction, not only to himself, but also to the present possessor of the instrnment. With respect to the Ramsden eyepiece, he had the opportunity of knowing that the late Mr. Thos. Ross thought highly of it and fully intended to have done something towards making it achromatic.

Mr. Ingpen said that Mr. Browning made a positive eyepiece which he believed worked well. He had omitted to mention the Barlow lens in the course of his former observations; it was, he thought, practically the same as Tolles' Amplifyer. Dr. Pigott said he had used and discarded it, but whether he gave it a fair trial before he took to his aplanatic searcher, he could not say. The aplanatic searcher no doubt arose from what was stated in the paper of Mr. Lister.

Mr. Burr observed that he had a Barlow lens made to his telescope, because he complained that he did not get the micrometer sufficiently magnified.

Mr. Ingpen said that the great Newall Telescope was found to be not achromatic, and that the defect of the object glass had been corrected by the use of a Barlow lens.

The Secretary read a letter from the Hackney Scientific Society to those members of the Club who recently rendered valuable aid as exhibitors of objects at the soirée of that society.

The proceedings then terminated with a conversazione at which the following objects were exhibited:—

Tibia of *Ovis Aries* (transverse and longitudinal sections	by Mr. G. Daintrey.
Isthmia enervis	" Mr. R. T. Lewis.

Palate of Whelk	by	Mr. Martinelli.
Sections of Coal (transverse, radial, and longitudinal	"	Mr. J. Russell.
Transparent injected section of Comb from Fowl's head...	"	Mr. A. Topping.
Fungoid growth upon moist water colours...	"	Mr. Watkins.

Attendance—Members, 67 ; visitors, 13.

March 14th, 1873.—Conversational Meeting.

Injected Jaw, and the Teeth of Cat	Mr. A. Topping.
Section of Coal, by reflected light, showing dotted tissue	Mr. Burch.
Ovisacs of Flea, stained with Carmine... ...	Mr. T. C. White.
Tracheal System of Flea	Mr. Fitch.
Section of Rush	Mr. Richardson.
Fibro-cells of Orchid. *Oncidium Harrisonii* (polarised)	Mr. Freeman.
Crystals from distilled vapour of Coke... ...	Mr. Curties.
Compound Ascidians	Mr. Swain.
Collection of cut and polished Agates	Mr. Swain.
Pygidium of Flea with ⅛th objective	Mr. G Williams.
Foot of *Cyphus gloriandus*	Mr. J. A. Smith.
Heads and Wings of Moths	Mr. Golding.
Tartrate of Potash...	Mr. Goodinge.
Proboscis of *Bogota* (polarised)	Mr. Sigsworth.
Fantail Fly (*Dolichopus*)	Mr. Danning.

Mr. T. C. White gave a ten minutes' lecture on the use of Staining Fluids.

Members, 58; visitors, 5. Total 63.

March 21st, 1873.—Annual Soiree.

The Annual Soirée was held, by permission of the Council, at University College, Gower Street, and was fully equal to any of its predecessors in the attractions it offered, and in the number of visitors present. We hope to give in our next number a detailed list of the principal objects exhibited.

On "Nobert's Tests."

By Wm Webb.

(Read 28th March, 1873.)

Practical knowledge, acquired by many years' study of the subject of this paper, and of analogous work, has induced the hope that I shall not be wholly frittering away your time. I have prepared engravings for printing my illustrations, so that as to that part of my paper there shall be no misunderstanding. Every statement of opinion shall be accompanied with a numbered specimen exhibiting that which I shall endeavour to pourtray in words. The specimens, if thought worthy of a place in your cabinet, you will honour me by accepting.

I may be forgiven if I state that astonishment and admiration upon my first examination, under the guidance of the late Mr. Ross, the agent of M. Nobert, and the kind assistance of Mr. Hewitt, of M. Nobert's Tests, betrayed me into an impulsive expression of incredibility and the cry, "Can such things be?" Perhaps my mind was as much impressed as that of any one, and, as a consequence, I worked at the subject with all the ardour of my nature as exhaustively as I was able. At the International Exhibition, 1862, despite the vibration of the gallery in which philosophical instruments were placed, and despite all the surrounding circumstances, I produced about half a dozen coarse specimens after Mons. Nobert. I have related the above bit of egotism simply that you may have a just appreciation of my labour of love. A very short study of the subject produced opinions totally at variance with those of every gentleman who (as far as I know) had expressed himself upon the matter, and that variation of opinion has never been altered, nor have I ever since been in accord with any one gentleman upon the subject. My first proceeding was to ask "What is a line?" My answer was "A line has length and breadth." If a white line be drawn upon a black board [thus] it will be seen that the line is bounded by black sides. To draw another line, the hand must be moved over or past an intervening space of black [thus], so that there shall be a black boundary to each side of the two lines.

The moment that intervening black space is annihilated by drawing a third white line, it becomes self-evident that the three lines have coalesced, and only present one line to the eye. About that I think there can be no controversy.

Having arrived at the conclusion that a line must have a space on each side of it before another line can be drawn, then arose the question, "What is the space between Nobert's lines?" I think it will not be very strong presumption to assume that every microscopist present is familiar with Dr. Jackson's Stage Micrometers, having lines including spaces of the one-thousandth of an inch, or with foreign stage micrometers with hundredths of millimetres in which the spaces are greatly in excess of the width of the lines, and the lines, comparatively coarse, because they are wanted to be used with low powers, with which, if the lines were very fine, they would be invisible. Ten of the lines the thousandth of an inch apart would approximately embrace the field of an eighth of an inch objective with an **A** eye-piece, as in my specimen numbered 1, to which I shall have again to refer presently. Divide one of those spaces of the one-thousandth of an inch by ten and spaces each of one ten-thousandth of an inch are obtained, as in specimen numbered 2, and this No. 2 is an analogue of Nobert's first band. To divide one of the one-thousandths of an inch by twenty would give spaces the one twenty-thousandth of an inch, as in specimen No. 3. To divide one of the one twenty-thousandths of an inch by ten would give lines each of one 200-thousandths of an inch, of which I have no specimen; and, at this point of the study, I diverge from the beaten path and come to the conclusion that if it be possible to rule lines with clearly defined spaces they can be crossed with similar lines, as in specimen No. 4, where the one four-thousandths are crossed by one four-thousandths, producing squares each one sixteen-millionths of an inch, which would, I believe, enclose the largest human blood corpuscle. In this way lines with spaces the one 200-thousandth of an inch crossing each other would produce squares each the one 40,000-millionths of an inch, or, as the newspapers usually misstate, such a number as the forty-billionth of an inch. I claim to have some knowledge of large figures, as applied to this subject, but the last one, as a ruled square, is beyond my credibility. With all due deference to every gentleman who has studied the subject, I respectfully suggest that beyond the first few bands of Nobert's Tests there is not one containing a line properly so called. The difference of opinion between gentlemen and myself

is so great that I am tempted to state as fully as I am able the reasons of my obstinate tenacity.

If it were possible by fluoric acid, or by other means, to procure a division from side to side—that is to say, across the middle of the bands of one of Nobert's Tests, the vertical section of the first band would present this appearance—

No. 5.

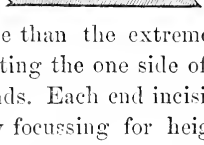
And this is all clear enough—the vertical section would test the Test. Applying this vertical test to the fine bands, quite another state of things will be found to exist. In this last specimen No. 5 has the surface untouched, except by each separate incision. I now advisedly adopt the word incision, for the word line applies no more to these diamond cuttings than it does to the Suez Canal. If the incisions were to be filled with black lead or other opaque substance, the surfaces would become palpable lines.

The first few bands would present the same state of things, maintaining the same clearly defined incisions, with intervening surface spaces, the optical effects of which I pass by for the present moment. Upon proceeding beyond the first few bands, and arriving at the fine bands, the vertical section would present the appearance of engraving

No. 6.

which is caused by the tool making contact thus, and moving

No. 6.



laterally a less distance than the extreme width of the incision, almost entirely annihilating the one side of each of the extreme or end incisions of the bands. Each end incision having unequal sides is most easily proved by focussing for heighth and depth with a moderately high power; but, when I come to the intervening incisions, the matter is complicated by other phenomena. To illustrate this clearly I have prepared the grossly exaggerated specimen No. 8. At this point of the investigation I cannot lay too much stress

upon, or too forcibly call attention to, the different appearances of specimens Nos. 1 and 2, as compared with No. 8, upon shifting the focus. With high powers the plane of observation does not include the whole of the depth of the incisions at the same moment—in other words it does not include at the same moment the surface of the glass and the lowest part of the incisions at any one stage of the focussing. The higher the power the less the depth of the plane of observation, or, as is well understood by the expression, the less the penetration. This likewise is easily proved by focussing downwards, and finding the first appearance is that of the upper surface of the glass, with clearly defined holes, which would seem to be continued through the substance; but, upon focussing a little lower, the upper surface is entirely lost to view, and the apparent holes through the glass become greyish black lines. Whence come these coloured lines? The glass is comparatively white! Why do not all the incisions present this dark appearance at the same moment?

At some phases of the focussing of the fine bands one incision will present two black lines. Whence come they? It is necessary to understand something of this phenomena before proceeding further with the subject. Microscopists are well aware of the polariscopic effects of colour, and of the fact of those colours being produced by refraction, or the bending of the rays of light at particular angles so as to produce only a portion of Frauhenhoffer's lines—the colour depending upon the particular angle of refraction and the particular portion of the solar spectrum brought under observation. To this polarization of the light by the bending of the rays transmitted through one bevelled side of the incision, intersecting, commingling with, and crossing the opposite rays, bent in an opposite direction through the other bevelled side of the incision is, very clearly, to my mind, to be attributed these embarrassing black lines. Upon examining specimen No. 9 with the unaided eye, and by powerfully reflected light at a particular angle, the whole of the solar spectrum is brilliantly exhibited, but that is due to the combination of reflection and refraction, while if it be possible to absolutely cut off the top light, and to absolutely destroy the reflection of the top light from Nobert's Test, the polarised refraction of the transmitted light would still be present in the black lines. The phenomena of these black lines become more involved by the fact of the different lengths of the sides of

the incisions in the fine bands, scarcely any one incision having its two sides of equal length in a direction from its lowest part to the apices of the ridge on each side of the incision. I say apex because there is no other space dividing the incisions. And these apices are of necessity irregular, because however rigid, however perfect, however true may be the instrument, however capable to a dead certainty may be the projection to the one 200-thousandths of an inch, the very nature of the material worked upon, with the two facts that the diamond has bevelled sides and the incision has bevelled sides also, create a tendency to elasticity in the machinery and materials, and as an evitable result the inequality of the ridges, which can only be revealed by this or some analogous test.

A little familiarity with the phenomena of the black lines prepares one to consider what must be the effect of the refracted ray from the long unbroken side of the outside cut crossing not only the refracted ray from the short side of the cut, but over the first apex and across the two rays from the two sides of the next incision. This complication of the phenomena has produced such a confusion of aerial polarised black lines of light as to embarrass the minds of some gentlemen, and driven them to resort to a declaration of "spectral lines" without giving the slightest hint of their source, and, apparently, wholly unconscious of the remarkable fact that the so-called spectral lines can never interfere with the examination of the incisions, if they were all equal in depth, inasmuch as the depth of the equal incisions and the spectral lines can never with high powers be in focus at the same time as in the equal incisions of the coarse bands where no one of the separate appearances, whether of apparent hole through the substance, or of black line, or of depth, are visible under high powers at the same moment as any one of the other appearances. I am not aware that the expression "spectral lines" has ever been applied to the coarser bands, which may possibly arise from the fact of the operator failing to recognise the dark beauties when arrayed exactly alike and with naught else than their own aerial presence visible at the same time. The production of the irregular polarised black lines I respectfully suggest is an incontrovertible proof that the diagram numbered 6, with its incisions having unequal sides, and its ridges of unequal heighth, is a correct representation of a vertical section of the fine bands, and the fact of Mr. Slack, after patient skilled labour, despairing of being able to obtain a definition of colloid silica because

of this refraction of light is strongly confirmatory of the accuracy of my views.

After much thought, I have come to the following conclusions, which I now submit, not as absolutely correct, but for the purpose of assisting other students in arriving at their own conclusions. For what they may be worth, I respectfully submit the following—

That a micrometer with lines the one 200-thousandth of an inch apart ruled on glass is an absolute impossibility.

That if it be possible to rule lines themselves of the width of the one 200-thousandths of an inch, to make them definable, there must be a clearly defined line between them.

And,

A clearly defined line in the same plane of observation.

That beyond the first few coarse bands of M. Nobert's Tests, there is not, properly so called, a single line.

That in the finest bands, except at their extreme sides, there is not half a line.

That in the finest bands the only thing certain, except the edges, is the uncertain polarised aerial lines.

That the microscopical world has been pursuing a phantom, and adopting a fallacy.

That polarisation of light in the examination of these and analogous tests is a deceitful servant of the microscopist.

That oblique illumination is another deceiver.

That if M. Nobert were to attempt to fill his incisions with black, his finest bands would be merged each into one black line of the breadth of each particular band.

That a test must be a known thing which some powers will either disperse or fail to define, as in the case of a spectacle vendor, who places before an intending purchaser's eyes, words printed in types of different sorts as a known test of visual powers.

That there are no tests so reliable as plain opaque lines.

That of plain opaque lines, there are none so reliable as a known measured congeries of contorted lines, as in microscopic writings, where the transmitted rays are partially shut off by the black, and in which the rays transmitted being transmitted by direct illumination their definition is not interfered with, such rays becoming parallel rays, passing out at right angles with the surface of the glass, the unalterable law of natural optics being that the angle of incidence and the angle of reflection are equal.

"Description of Turpentine Bath."

By the Rev. H. G. W. Aubrey, Hale, Salisbury.

Communicated 28th March, 1873.

The Turpentine Bath which has been prepared for me by Mr. Curteis in accordance with my directions has proved so useful and convenient that some account of it may be acceptable to the working members of the Quekett Club. An exact description is unnecessary, as a model of the bath is sent for inspection.

It was designed with a view to cleanliness and facility in handling objects during maceration, and to economy of space and of turpentine. In all these points it seems to me superior to the common method of tying and plunging the slides into turpentine. Assuming that all the necessary pressure for flattening the object has been applied during the drying process, the slide has only to be removed from the drying holder and slipped carefully into one of the brass cradles or holders and suspended in the bath. No pressure is exerted by the holder upon the covering glass, nor is it necessary. In most cases the drying process has caused sufficient adhesion of the thin glass to keep it in its place during the maceration, and if it does slip away, which with small objects is not uncommon, no injury is done, but rather an advantage gained, for it allows a final touch to be given to them, and also the complete and easy removal of the superfluous turpentine before the application of the dilute balsam. I have never found either cover or object slip into the bath from the slide. The breadth of the brass holders gives sufficient support to prevent this. Clips of steel might be substituted for the brass ones if it was thought desirable to secure the cover glass by pressure during the maceration, but would considerably increase the expense, without much additional advantage. The form of the brass holders is important, but if the pattern be carefully followed there will be no fear about their working successfully. It will be observed that when suspended from the lateral ledges the holder does

not reach the bottom of the dish. This allows a space for any grains of dirt which may gravitate downward from the vertical position of the slide and object to float free of both, and when the holder is lifted out it is at once clear of the sediment. Occasionally it is desirable to empty the dish and run the turpentine through a filter of blotting paper and return it. It is not necessary to use more turpentine than will reach about half way up the slide when lying in the holder. In the matter of space I do not see how the same number of slides could be more conveniently packed. In my first bath, measuring six inches by three and a half, I have now sixteen objects suspended, with room for two or three more if I had more holders. Any one of these I can at once withdraw from the bath without disturbing the others, can place under the microscope, and according as it seems ready for balsam or not, can shift for a fresh slide to be put in soak, or replace in the turpentine. I shall be glad if this bit of apparatus should prove of use to any member of the society. I have reason, from extended experience, to think it a really serviceable appliance.

On the Histology of Plants.

By R. Braithwaite, M.D., F.L.S.

II. Origin of the Plant Cell.

(*Read June* 27, 1873.)

Having become acquainted with the structure of the cell as an individual, we have next to consider how cells originate, for on the constant formation of new cells all growth depends.

A plant cell always arises within another, which is thus appropriately termed the mother-cell, and it is either the contents or the primordial membrane of the mother-cell, which is the active agent in the process; in the former case we have *Free cell formation,* in the latter *Cell formation* by *division.* Dippel has so ably elucidated this difficult subject that I cannot do better than lay before you the result of his observations throughout.

1. Free Cell Formation.—This was first noticed by Wolf a century ago, but for a clear definition of the process we are indebted to the researches of Prof. Schleiden. It is of universal occurrence when once the first cell of a commencing organism has been formed, and may be observed in the spermatozoids and spore-cells of the higher cryptogams, in all germ cells, in pollen cells, and in the embryo sac of Liliaceæ, Iridaceæ, Compositæ, Onagraceæ, &c.

Two modifications may be distinguished—(1) when one or more free cells arise without the original contents being consumed; (2) when one or more daughter-cells use up the contents of the mother cell, which thus perishes, its cellulose case continuing for some time, protecting the new cells. The first form is seen in the embryo sac of flowering plants, and may be readily observed in the Liliaceæ, where this organ is very large, even just after impregnation. A thin central slice is placed in very weak solution of gum, and in the parietal protoplasm of the embyro sac we may find all stages of the growing cell containing free nuclei of various sizes,

in which we may distinguish a nucleolus and distinct envelope. As development progresses the nuclei collect round them more and more protoplasm, and in the cell cavity one or more vacuoles appear, filled with cell-sap. The second form is seen with one daughter-cell, in the central cell of the archegonium of mosses and ferns, in the resting spores of some Algæ, as *Spirogyra*, *Œdogonium*, &c., in the spore-forming cells of higher cryptogams, and in Pollen cells of Phænogams. In the archegonium of mosses and Hepaticæ the central cell may be readily observed; granular protoplasm collects about its nucleus, and is well defined from the other cell-contents ; the mother-cell, constantly enlarging, distends the ventral part of the archegonium, and the young germ cell, invested only by the primordial membrane, grows quickly, and at last quite fills the mother-cell, the contents of which have been completely consumed in the process. If impregnation does not take place the contents of the germ-cell gradually become coloured brown, and the membrane disappears ; but if the archegonium is impregnated we find that resorption takes place in the wall of the mother-cell turned toward the neck of the archegonium, the germ-cell becomes invested by a double-contoured cellulose case, while in the contents large vacuoles form, and fine internal currents may be seen running between the nucleus and the parietal protoplasm of the cell.

Origin of Tetraspores and Pollen-grains.—In these the primordial membrane appears to be formed round the whole contents of the mother-cell, in which free cells form, and the cellulose case is not the youngest layer of the so-called special mother-cell, as Schacht and others teach, for at a certain age the primordial utricle of the mother-cell disappears, and afterwards its contents are invested by one which is not in immediate contact with the cellulose envelope.

From this stage of development the young pollen cells advance from the broken-up mother-cell, and appear surrounded by a sharply defined nitrogenous membrane, which contracts by application of iodine or syrup. To this membrane of the daughter-cell, then applies itself the young primary cellulose case of the pollen grain, regarded by Schacht as a thickening layer of the pollen mother-cell.

In the sporangia of some Fungi (*Tuber*, *Peziza*, *Sphæria*, &c.), and in Lichens, the resting spores arise as free daughter-cells,

which consume the whole contents of the mother-cell during their development; and the same is seen in zoospores of many filamentous Algæ and Fungi (*Peronospora*, *Saprolegnia*, &c.).

After the destruction of the nucleus of the mother-cell, we observe as many nuclei as there are daughter-cells developed. Round. each of these is collected a denser mass of protoplasm, which becomes invested by the primordial membrane, and then by the cellulose case, and thus the new cells are complete. In the resting spores of Fungi, according to recent observation, a previous impregnation is necessary to originate the cellulose case, just as in the embryo-cell of higher plants.

The rapidity with which cells often multiply is truly marvellous; thus in that great Puff-ball *Bovista giganteum*, which we frequently find bigger than a hat, it has been calculated that 20,000 new cells are formed every minute, and Kieser estimates the tissue of some fungi to increase at the rate of 60,000 per minute. The sudden appearance of large tracts of water discoloured by minute Algæ is also thus readily explicable.

2. Cell Formation by Division.—Here the contents of the mother-cell, by a contraction or lacing-in of the cell-membrane, are divided into as many parts as there are new daughter-cells, and this process also offers two types. In one we have complete division of the living cell, *i.e.*, the membrane and contents, along with *simultaneous* division of the cellulose case; in the other, during the advancing contraction of the primordial membrane of the mother-cell, the division of the cellulose case occurs *subsequently*. In the first group a bipartite division only has been observed, but in the second both 2 and 4 parting occur. Bipartition, with subsequent formation of the case round two daughter-cells, is best seen in the filamentous Algæ, and the multicellular hairs of Phænogamous plants; whilst the origin of 4 daughter-cells may be observed in the formation of the mother-cells of spores and of pollen.

Cell Division, with Simultaneous Division of the Cell-case may be observed in higher plants, in the parenchyma of the growing point, in formative tissue, and in the advancing development of the albumen of the seeds of phænogamous plants; the observation is, however, difficult on account of the obscurity of the cell contents, but is most readily seen in the wide celled root-wood of Conifers. The new cambial growth takes place later in the root than in the stem and branches, so that if early in summer we take thin

transverse sections of the roots of the common pine, and apply any of the endosmotic reagents, we may observe the various stages.

The division commences by a folding-in of the primordial membrane; the partition of the cambial wall (not consisting of cellulose) proceeds at the same time over the whole membrane; after which the mother-cell is quickly resorbed and converted into intercellular substance.

In deciduous trees multiplication of cells proceeds in the same way, but those forming vessels extend rapidly, and attain their normal size before other tissues.

Cell Division, with Subsequent Partition of the Cell case.—Bipartition of the second type may be studied most completely in the filiform Algæ, as we may keep the specimens in shallow troughs constantly under observation, and of these *Cladophora glomerata* is a suitable example.

If we place a small portion under the microscope, and carefully examine the terminal cell of a branch, we often find that division has already commenced, for such cells are twice the length of the others. The first thing we notice is, that two clear spots near the middle of the cell stand away from the margin, and this is caused by a collection of colourless protoplasm; then the primordial membrane of the mother-cell, more active at this point, folds inward like a ring, which, gradually advancing, laces in the contents in two halves belonging to both daughter-cells; this infolding is most distinct in slow growing plants, cultivated indoors. Immediately after the infolding of the primordial membrane begins, the division of the cellulose case commences, and advances continuously with the infolding, so that soon after complete division the daughter-cells have also acquired a delicate but distinct cellular case.

A cementing intercellular substance appears where the part of the mother-cell case, cut off between the cross-walls, has become nearly dissolved. The application of endosmotic reagents gives us a clearer view of these details. A triangular intercellular space is seen at the junction of the daughter-cells, which is most distinct in the slow-grown specimens, for in luxuriant tufts the primordial membrane and young cellulose case become pressed together and to the mother case, and this space almost entirely disappears.

This accounts for the error of Pringsheim and Von Mohl, that in the commencing infolding of the primordial membrane a cellulose

bar is projected inward; the infolding of the primordial membrane is instantly followed by division of the cellulose case.

To study the division of the cell nucleus, which in *Cladophora* is concealed by the other contents of the cell, we have better material in *Spirogyra*, *Zygnema*, and *Ulothrix*, in which division begins with that of the nucleus of the mother-cell, and as soon as this is completed, infolding of the primordial membrane commences.

In *Œdogonium*, if we examine a mother-cell before it attains division, we find the upper of two adjacent cells appears enclosed by two cellulose membranes; the inner, more strongly developed, forms the cellulose case of the cell under observation; the outer, extremely thin, belongs, on the contrary, to the preceding generation, *i.e.*, the mother-cell, in which the two cells before us have been formed. In the lower of the two cells, yet a third coat is apparent, which, close under the upper end joining the first cell, is cut off by a distinct transverse line, indicating the place of previous division. The commencement of the process is seen in an infolding of the inner cellulose case just under the youngest cap, so that the cell contents appear drawn in by a ring, the space between the fold and the outer case being empty. During the formation of this ring-fold, the nucleus lying in the upper half of the mother-cell enlarges to double its original size, and then divides into two nuclei—one for each daughter-cell—and at the same time on a level with the line of division of the nucleus appears a ring-like collection of colourless protoplasm, immediately followed by an infolding of the primordial membrane, which divides the mother-cell into two daughter-cells, the upper of which is the shortest. But before the lacing-in of the membrane is completed, the outer case splits gradually, just above the infolding of the cellulose case, which then becomes stretched out, so that the fold disappears.

With the division of the young cellulose case, the lower daughter-cell elongates and pushes the upper one before it, while the cellulose case of the mother-cell becomes more and more elongated. As soon as the lower daughter-cell has grown up to the transverse stria of the sheath, produced by the splitting of the outer case, the division appears, *i.e.*, the unlacing is completed, and the young cellulose case has developed over the primordial membrane, so that now two complete daughter-cells are present. Now

also commences by continued separation of cellulose, the extension of the upper daughter-cell, which thus gradually attains the length of the lower one. The cellulose case of the mother-cell, following the extension of the daughter-cell, has now become the thin outer case, and the development of the two daughter-cells has reached the point at which we first started. The difference between the cell-division of *Œdogonium* and the other filiform Algæ consists in this, that the mother-cell does not, as in them, before the formation of daughter-cells, extend to double its length; but in consequence of growth taking place only at its point, the old membrane no longer extensible becomes infolded in the same way as in the formation of pores, and the extension of the mother-cell first commences when the firm outer case has been ruptured by force of growth, the caps being thus thimble-shaped portions of the cell-case.

Division in Four.—This proceeds in two ways, the mother-cell either divides into two daughter-cells, each of which repeats the process, or four daughter-cells are at once formed; the former occurs only in the origin of the mother-cells of pollen in Monocotyledons, the latter in that of Dicotyledons, and the spore mother-cell of the higher Cryptogams. The first-named is best seen in the Liliaceæ by a section of a very young flower-bud; at a point of the nucleus, two daughter-cell nuclei appear by division, and this is followed by the lacing in of the primordial membrane, and the division of the cellulose case, so that this is present as a thin membrane soon after the two daughter-cells have become defined, and in them the same process is again repeated. We use solution of sugar or iodine to demonstrate this drawing in of the Primordial utricle in young dividing cells, as the contents become thereby contracted, together with the primordial membrane embracing them, while the whole interior of the cellulose case is quite smooth, and without any trace of the formation of transverse walls. When the infolding of the Primordial membrane is farther advanced, we first observe on the inside of the mother cellulose case, the newly separated cellulose case of the daughter-cells.

The pollen mother-cell of Dicotyledons is best observed in plants with large anthers, as species of Cucurbita, Mallow, or Convolvulus. In the Gourd or Hollyhock, the primary cellulose wall of the young mother-cell is provided with peculiar hair-like elevations, which gradually disappear as thickening of the coat advances. The

nucleus of the mother-cell divides into two daughter nuclei, which separate and each again divides in two, so that four free nuclei are seen in each mother-cell, lying in a plane or tetraedrally, and the infolding of the primordial membrane then takes place, lacing in the contents into four portions, and thus forming four daughter-cells.

The spore mother-cells in the higher Cryptogamia are easily seen by section of young capsules, especially those which have large spores, as the Phascoid mosses, *Fegatella conica*, &c.

In *Pellia epiphylla* the wall of the mother-cell bulges out over the four nuclei, and constantly extending in the same direction, while it contracts at the centre, which becomes translucent, the four daughter-cells appear fixed together by pedicels. Division into four in form of rows has only been observed by Schacht in the quadrifid fructification of *Corallina* and *Melobesia*.

Having thus briefly considered the various modes of reproduction in cells, in which, by-the-bye, you will find no grounds for the statements of some authors that cells may be developed from vacuoles—a process, indeed, which I consider to be impossible—you will at once perceive the value of the microscope in our researches, for without it any clear conception of these mysterious processes could never have been attained. Although the subject may appear a dry one to some of you, its importance in the study of the subsequent transformation of cells must be my excuse for devoting so much time to its explanation.

Illustrative Figures.

Plate 7.

Fig. 1.—Free cell-formation in the embryo sac of *Phaseolus multiflorus*. *n.* nuclei, *a. a.* young cells, *b.* more advanced, c. still older, enclosed in the cellulose case. × 670.

Fig. 2.—Spore formation in *Peziza leucoloma*. *a.* spore sac with a central nucleus *n.*, and several vacuoles *v.*—*b.* The same after division of the nucleus into young spores. *c.* ditto, with the cellulose case fully formed. × 620.

Fig. 3.—Cell division in *Cladophora glomerata*. *a.* commencing infolding of the primordial utricle, *b.* the same, more advanced, the line of division marked out; *c.* the partition completed. × 400.

Fig. 4.—Cell division in *Œdogonium apophysatum.* × 670.

a.—Cell preparing to divide, c^1 its cellulose case, c^2 ditto of the mother cell, *o.* a third case or sheath over the lower cell, truncate at top, *n.* nucleus, *s.* annular fold of the cellulose case.

b.—Division of the mother-cell commencing, *m.* partition between the two new daughter-cells.

c.—Division completed, *o.* sheath, *d. c.* daughter cell, *m. c.* mother cell.

Fig. 5.—Division of the mother-cell of the spores in *Pellia epiphylla*, *a.* mother-cell, *b.* the same, with commencing protrusions and nuclei, *c.* spores enclosed in their cellulose case. × 420.

PROCEEDINGS.

THE SOIREE OF THE CLUB.

The Annual Conversazione of the Club was held, by the kind permission of the Council of University College, in the Library and Museum of that Institution, on Friday evening, March 21st, and was as interesting in the character of the objects exhibited as on any previous occasion. It was attended by about 1,000 visitors, amongst whom might be recognised many of eminence in Art, Literature, and Science.

By the kind assistance of a member of the Club, Mr. James Martin, of the London Stereoscopic Company, the Soirée Committee were enabled to exhibit a series of views by means of the Oxy-hydrogen Light, illustrating the African Gold and Diamond Diggings, the Victoria Falls, and some of the places intimately connected with the travels of Dr. Livingstone.

Mr. Apps exhibited a series of beautiful electrical experiments, by means of his Inductorium and some apparatus kindly lent for the occasion by Lord Lindsay.

Mr. How exhibited with the Oxy-hydrogen Lamp some Micro-photographs of Rotiferæ, taken from life by Dr. Gayer, one, the image of a Volvox globator, being magnified four feet in diameter. Two Marine Aquaria, filled with Actiniæ, Sabellæ, Serpulæ, Madrepores, and Hippocampi, were kindly lent for the evening by Mr. G. H. King.

The leading opticians came forward on this occasion with their usual kindly help, and contributed microscopes, graphoscopes and revolving stereoscopes, while the walls were ornamented by a series of microscopical drawings, executed by Mr. Rochfort Connor, and admired, as they always are, for their delicacy and accurate fidelity. The members of the Club were reinforced by their friends of the Croydon, South London, and Forest Hill Societies, in the exhibition of the following objects of interest:—

Lung of Boa Constrictor	exhibited by	Mr. F. W. Andrew.
Infant's Brain	,,	,,
Jawbone and Tooth of Mouse	,,	Mr. F. W. Andrew, jun.
Human Scalp, showing Follicles ...	,,	,,
Æcidium berberidis	,,	Mr. E. C. Baber.
Fossil Bone of Dinornis...	,,	Mr. Bailey.
,, Irish Elk	,,	,,
Potato Starch (polarised)	,,	,,
Proboscis of Death's Head Moth (India)	,,	Mr. C. W. Balls.
Young Oysters	,,	Mr. Thos. Bevington.
Santonine	,,	Mr. W. A. Bevington.
Larvæ of Dragon Fly	,,	Mr. W. Bishop.
Head of Nubian Mosquito	,,	Mr. W. J. Brown.
Pond Life	,,	Mr. G. J. Burch.
Diatoms *in situ*	,,	,,
Larvæ, &c....	,,	,,

Moller's Typen Platte	,,	Mr. Burgess.
Micro-photographs of the Moon ...	,,	Mr. T. W. Burr.
,, 1. Age 6 days	,,	
,, 2. Age 9 days	,,	
Microscopic Writing—The Lord's Prayer in $\frac{1}{2700}$ of an inch	,,	
Section of Rhinoceros Horn (polarised)	,,	Mr. R. Catchpole.
Stephanoceros	,,	Mr. W. G. Cocks.
Volvox Globator	,,	,,
Conochilus	,,	,,
Ova of Toad (injected)	,,	Mr. Rochofort Connor.
Vinegar Eels (Anguillula)	,,	Mr. E. A. O. Creer.
Larva (unknown) from Bark of Pear Tree	,,	Mr. J. S. Crisp.
Young Salmon (just hatched)	,,	Mr. Thos. Crook.
Volvox	,,	,,
Crystals (polarised)	,,	,,
Section of Coal	,,	Mr. Alfred Cowley.
Transverse Section of Hare's Tooth ...	,,	Mr. P. Cowley.
Microscopic Camera	,,	Mr. Thos. Curties.
Young Salmon	,,	,,
Palate of Mollusc	,,	,,
Wing of Butterfly (Azure Blue) ...	,,	Mr. H. Curwen.
Injected Skin of Frog	,,	Mr. W. A. Duck.
Section of Proventriculus of Fowl ...	,,	,,
Injected Lung of Toad	,,	,,
Head of Humming Fly	,,	Mr. C. G. Dunning.
Drum of Frog's Ear (injected)	,,	,,
Tongue of Honey Bee	,,	,,
Skin of Frog (injected)	,,	,,
Ciliary Action in Mussel...	,,	Mr. F. Fitch.
Arrenurus (a Green Water Mite) ...	,,	,,
Design in Selenite (clockwork polariscope)	,,	Mr. C. J. Fox.
Volvox Globator	,,	Mr. C. J. Fricker.
Melicerta Ringens...	,,	Mr. G. H. Fryer.
Acarus glyciphagus prunorum	,,	Mr. F. W. Gay.
Skin of Sturgeon (polarised)	,,	,,
Leg and Foot of Dytiscus	,,	Mr. Garnham.
A Beetle	,,	Mr. W. H. Golding.
Gold Quartz...	,,	,,
Eyes of Moth	,,	,,
Scales of Butterflies in form of a Bouquet in a Vase of Diatoms ...	,,	Mr. A. Goode.
Daphnia Pulex	,,	Mr. J. W. Goodinge.
Angillula glutinis...	,,	,,
Earth Mite	,,	Mr. H. J. Gray.
Section of Wild Rue Seed (polarised)...	,,	Mr. Thos. Greenish.
A Collection of Foraminifera	,,	Mr. H. F. Hailes.
Tingis sp. (?)	,,	,,
Conochilus	,,	Mr. Hainworth.
Volvox Globator	,,	,,
Head of Coneatus tamarisi	,,	Mr. Hembry.

Deep Sea Soundings	,,	Mr. F. Hind.
Skin of Sole	,,	,,
Paulownia imperialis	,,	Mr C. W. Hovenden.
Hydra	,,	Mr. F. Hovenden.
Pollen of Malva Sylvestris	,,	,,
Tongue of Trochus	,,	Mr. Howe.
Salicine (polarised)	,,	,,
Young Hippocampus	,,	,,
Cholesterine (polarised)	,,	Mr. Howell.
Scales of Sole (polarised)	,,	Mr. J. E. Ingpen.
Volvox Globator	,,	Mr. B. D. Jackson.
Vessels in Rhizome of Philodendron ...	,,	,,
Hairs in Leaf of Deutzia Crenata ...	,,	Mr. J. A. Johnson.
Distillation from Vapour of Coke ...	,,	Mr. E. F. Jones.
Shells from Hastings Sand	,,	Mr. E Kiddle.
Platino-cyanide of Magnesium... ...	,,	,,
Eggs of Moth (triangulum)	,,	,,
Crystalization of Silver	,,	Mr. R. T. Lewis.
Polycistinæ...	,,	,,
Section of Hoof of Horse...	,,	Mr. W. T. Loy.
Wing of Ornithoptera Crœsus	,,	Mr. L. Manners.
Wing of Ornithoptera Richmondii ...	,,	,,
Euglenæ virides	,,	Mr. A. Martinelli.
Fern Scales (polarised)	,,	Mr. Moginie.
Butterfly Scales arranged as Bouquet ...	,,	,,
Microscopic Writing	,,	,,
Footpads of Diamond Beetle	,,	,,
Revolving Stereoscope	,,	,,
Human Scalp (vertical section)	,,	Mr. Needham.
Human Scalp (horizontal ditto)	,,	,,
Negro Skin	,,	,,
Hylodactylus	,,	Mr. Nelson.
Salicine (polarised)...	,,	Mr. M. D. Northey.
Circulation in Young Trout	,,	Mr. F. Oxley.
Daphnia Pulex (polarised)	,,	Mr. Parks.
Human Scalp (horizontal section) ...	,,	Mr. Pett.
Spicules of Synapta	,,	Mr. W. T. Rabbits.
Section of Intestine of Fowl (polarised)	,,	Dr. Ramsbotham.
Section of Blow Fly	,,	,,
Aecidium urticæ	,,	Mr. W. W. Reeves.
Aecidium quadrifidum	,,	,,
Aecidium ranunculacearum	,,	,,
Foraminifera	,,	Mr. E. Richards.
Calcedony	,,	Mr. E. Robins.
Caddis Worm (polarised)...	,,	Mr. Thos. Rogers.
Volvox	,,	Mr. Jas. Russell.
Hydra Viridis	,,	,,
Volvox, covered with Vorticellæ ...	,,	Mr. Jos. Russell.
Star Fish	,,	,,
Circulation in Vallisneria spiralis ...	,,	Mr. J. E. Simmonds.
Section of Coal	,,	Mr. J. Slade.

Polycystina	,,	Mr. A. Smith.
Larva of Gnat	,,	Mr. J. A. Smith.
Tiger Beetle	,,	Mr. Jas. Smith.
Pond Life	,,	,,
Culex pipiens	,,	Mr. R. A. Smith.
Palate of Limpet	,,	Mr. C. W. Stidstone.
Rotation in Vallisneria	,,	Mr. D. J. Stuart.
Diatomaceæ	,,	Mr. W. T. Suffolk.
Section of Granite (polarised)	,,	Mr. T. Terry.
Circulation in Frog's Foot	,,	Mr. Topping.
Sheep Tick	,,	,,
Jaws of Male Spider	,,	,,
Compound Eye of Fly, Tabanus ...	,,	,,
Section of Lucifer Match (polarised) ...	,,	Mr. S. Warburton.
Anther of Mallow	,,	,,
Green Weevil	,,	,,
Crystals of Chlorate of Potash (polarised)	,,	Mr. F. H. Ward.
Thallic platino-cyanide (pol.)	,,	Mr. J. Watkins.
Salts Distilled from Coke (pol.)... ...	,,	,,
Circulation in Frog's Foot	,,	Mr. West.
Atlantic Soundings (polarised)	,,	Mr. F. W. White.
Human hair (polarised)	,,	,,
Hippuric Acid (polarised)	,,	Mr. T. C. White.
Small Marine Aquarium	,,	,,
Human Scalp (horizontal section) ...	,,	,,
Ballia Callitricha, with Anguinaria Spatulata attached	,,	Mr. Jas. F. Wight.
Oniscus (polarised)...	,,	Mr. Geo. Williams.
Sugar of Milk Crystals (polarised) ...	,,	,,
Micro-photograph (Elephant's, from life)	,,	,,
Oniscus aquatilis...	,,	Mr. Worster.
Eggs of Vapour Moth	,,	,,

MARCH 28TH, 1873.—*Chairman*, Dr. R. BRAITHWAITE., F.L.S., President.

The following donations to the Club were announced:—

"The Monthly Microscopical Journal"	from the Publisher.
"Science Gossip"	,,
"The American Naturalist"	in exchange.
"Proceedings of the Literary and Philosophical Society of Manchester	from the Society.
"Proceedings of the Royal Society," No. 142 ...	,,
List of Fellows, Members, &c., of the Royal College of Physicians, 1873	the College.
"Archives of Science of the Orleans county Society	in exchange.
"Journal of the London Institution"	from the Librarian.
"Annual Report of the Geologists' Association"	,, the Association.
"The Lens"	in exchange.
Eight Slides	from Mr. Jas. Watkins.

The thanks of the Club were voted to the donors.

Mr. Frank Bridgman and Mr. Brooke U. Lacy were ballotted for, and elected members of the Club.

The Secretary read a communication from the Rev. H. G. W. Aubrey, describing a new form of turpentine bath for microscopic slides which he had lately designed, and which was sent to the meeting for examination.

Mr. Greenish thought that one objection to the use of this bath would be the large surface of turpentine exposed to the air, as this would be likely to cause a deposition of resin. Turpentine exposed in this way would be sure to oxidise.

Mr. Golding noticed that provision appeared to have been made against this by a piece of india-rubber running all round the top, so that the bath would be quite air tight when the cover was fixed on.

The President said that some years ago he had occasion to soak objects in turpentine for the purpose of decolorizing them, and he used to place them between pieces of glass, which he tied together, and then lowered into the turpentine with a piece of string. After remaining there as long as was requisite, he drew them out, and then mounted them in balsam in the usual manner. The Rev. Mr. Aubrey's invention appeared to be for doing the same thing in a more convenient and elaborate manner.

The thanks of the meeting were voted to Mr. Aubrey for his communication.

Mr. Locke thought that he need not say that the matter of mounting objects dry, and so as not to spoil afterwards, was one of very great importance. Most persons present had probably experienced the great annoyance of finding that things which they thought were nicely mounted presently became damped and were utterly ruined. He thought, however, that he had, after many endeavours, at last contrived a plan which, so far as preventing this evil was concerned, he believed was perfect. His process was a simple one—he took an ordinary elastic india-rubber band of the same size as the glass cover it was intended to use and put it upon an iron plate ; he then held it for a short time over the flame of a spirit lamp until the under side of the ring was frizzled. This being done, he turned it over on the iron plate and fried the other side, after which he allowed it to cool, and then dropped it into a glass of water; it was then ready for use. He next took a slide, and having dried it thoroughly, took the india-rubber circle out of the water and put it into its place on the slide, then dried it carefully over the lamp to extract all the moisture from it, and taking the scales or diatoms it was desired to mount, he put them upon the covering glass, and laying this upon the softened ring, pressed it down with the finger, which caused it at once firmly to adhere, and as there was no cement used and the ring did not evaporate, the result was a perfectly dry mount. Some time ago he had two slides from Mr. Swift to experiment upon ; they were utterly ruined by damp, but he took them to pieces, and having contrived an oven in which to dry them, he allowed them to remain there for five or six hours, and then mounted them again in the manner described, and no signs of damp have since appeared, so that he believed it had been perfectly successful. Bands could be easily procured of all sizes, and if treated in this way, they would adhere firmly both to the slide and the cover by themselves. The slides which he had brought with him to the meeting as specimens had been finished about three months. He also wished to direct the attention of the members to a simple method of altering the illumination from direct to oblique which he had designed and adapted to a microscope then in that room.

The President proposed a vote of thanks to Mr. Locke for his communication.—Carried unanimously.

Mr. Golding asked if there was not some danger of Podura Scales falling about in so great a space as that contained by the india-rubber ring?

Mr. Locke said that he had found in practice that scales once placed upon the glass cover would adhere to it and remain there. Of course if there were any contact between the cover and the slide the scales would be damaged, and he thought it impracticable to get a cell of exactly the depth required.

Mr. Greenish inquired what was the object in heating the cell; why was it better then than otherwise?

Mr. Locke said that his object in heating it was to make it adhesive; in its ordinary condition it would not adhere by itself, and, if fixed on with varnish, that would evaporate inside as well as outside the cell.

Mr. Greenish thought it was quite possible that by decomposing the india-rubber in that way an element was introduced which might prove very inconvenient.

Mr. Burr suggested that the vulcanized india-rubber contained sulphur.

Mr. Golding thought it probable that the sulphur was got rid of by heating the rings in the manner described.

Mr. Greenish said that at a former discussion upon a similar subject a member had stated that he had found the sulphur to be very injurious.

Mr. Locke said that on one occasion being too anxious to get the cell perfectly dry he had heated and softened the ring too much, and found that on cooling it collapsed from the pressure of the atmosphere. He thought this conclusively showed how perfectly air tight it must have been.

The President said it showed that sufficient heat was applied to drive out all the air from the cell.

Mr. B. D. Jackson thought there was one important question which had not been touched upon, and that was the permanent nature of the ring. He also thought that the large space between the object and the condenser, owing to the thickness of the ring, would act prejudicially against proper illumination of diatoms or scales.

Mr. Locke said that it might possibly be so, but it should be remembered that in mounting objects of extreme tenuity they were always placed on the cover and not on the slide.

Mr. Jackson remarked that Ross's $\frac{4}{10}$ condenser certainly would not work up near enough to the cover of the slide which had been handed round for inspection.

Mr. Locke thought that in this case they must, as in all others, do the best they could.

Mr. T. C. White suggested the employment of thin sheet gutta-percha instead of india-rubber.

Dr. Gray believed that a piece of sheet gutta-percha would be found to answer the purpose very well; it could be obtained of any thickness. Dr. Tulk recommended it to him, and he found that it made a perfectly air tight cell. For such things as scales nothing could be better than a cell made of thin sheet gutta-percha fixed to the slide with a little electrical cement run round the edge; it would run under by capillary attraction, and formed a capital cement for the purpose.

Mr. Greenish said it should be borne in mind, with regard to gutta-percha and india-rubber, that both underwent decomposition spontaneously from exposure to the air.

Mr. Locke thought that if the cell was air tight, and a coat of varnish was ap-

plied which would not dissolve, the ring would entirely obviate the danger of decomposition from contact with the air.

Mr. William Webb read a paper upon Nobert's Tests, illustrating the subject by drawings upon the black board.

The President said he was quite sure that all the members of the Club would feel very much obliged to Mr. Webb for his paper; it opened up a great many thoughts upon the subject, and the explanation given of the cause of the shadows seen in the closer bands seemed so simple that it must carry conviction with it.

Mr. Webb regretted that great pressure of engagements had prevented him from going near his workshop for the last fortnight, so that he was unable to bring with him any specimens in illustration of his remarks. He hoped, however, to be able to do this at their next gossip night, and would then endeavour more fully to explain his meaning.

Mr. Ingpen thought that many of Mr. Webb's observations would be endorsed by those persons who had used Nobert's lines as a test for the defining power of their objectives. He had himself tried them for that purpose, and had given them up, and his conclusions coincided very nearly with those of Mr. H. J. Slack as given by that gentleman in a paper on "Optical appearances of cut lines in glass," which was read before the Royal Microscopical Society, and printed in the "Monthly Microscopical Journal" for May, 1871. Of course in looking at the coarser bands of Nobert the furrow of each line, the angle, and the two edges were perfectly plain, as was also any little dirt which might have been upon the edges, but this clearness soon vanished when they came to examine the higher bands, and he thought that Mr. Webb's suggestion as to the reason for this was very likely to be near the truth. Even when the higher bands had been resolved it was not in the same satisfactory manner as in the case of the lower ones. With whatever clearness they might be shown, there was always a row of lines on each side blacker and clearer than any of the others—an appearance which he thought was seen in some of Dr. Woodward's photographs, and which possibly were defraction lines, and which the last edge shown on Mr. Webb's diagram was quite capable of producing. As to the spectral lines, he fancied that Mr. Webb was slightly in error in referring them to polarization, because there was, he thought, nothing either in the substance or the angle to polarize the light. The effect was, however, very possibly due to diffraction; it was, in fact, similar to that produced by the ruled gratings such as were exhibited at the soirée. The light was, he thought, decomposed and separated into its component colors by interference caused by diffraction. The spectral lines seemed due to the formation of an image either above or below the focus, but they did not appear to be in any degree the result of polarization. Of course the question as to tests, and as to what was the best, and whether these would be so when blackened in, was one still open for settlement; if the whole surface of the glass (supposing it to be cut away as shown in Mr. Webb's diagram), were to be blackened in, that at least would hardly constitute a test. For his own part he could not imagine that a test could be obtained either for chromatic or spherical aberration either by straight lines ruled on glass or by irregular lines, such as letters, and he must say that his strong impression was that none of the tests at present used, whether the globules of mercury, or scales, or even the vexed Podura, were entirely satisfactory. He thought that they were all very much indebted to Mr. Webb for his paper, and for the many valuable suggestions contained in it.

The President moved a vote of thanks to those gentlemen who exhibited objects at the soirée, and to the Soirée Committee by whom the various arrangements were made.

The Secretary seconded the vote of thanks, and mentioned that although no notices were sent beforehand so many members came forward as exhibitors that it was almost a matter of difficulty to find space for all without inconveniently crowding.—Carried unanimously.

The Secretary, in reply to Mr. Curties, stated that the Cabinet would very shortly be again opened to the members; it had been thoroughly overhauled and its contents re-arranged, and a complete catalogue of the slides had been prepared and printed. As soon as it was possible to go through them all and check them off by the catalogue the Cabinet would be placed upon the table and be accessible to the members on the gossip nights.

The Secretary also announced that the excursion season would commence in April, the first being arranged for the 5th of that month—to Barnes.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Platino-cyanide of Magnesium	by Mr. Curties.
Ciliary action on surface of Tadpole's body ...	Mr. Fitch.
Hairs of Lion, Mole, &c. Pyro-gallic acid	Mr. Golding.
Platino-cyanide of Strontian	Mr. Goodinge.
Halodactylus with diatoms in its stomach ...	Mr. Ingpen.
Eggs of Vapourer Moth	Mr. R. T. Lewis.
New mode of illumination	Mr. Locke.
Hairs of Hippophäe rhamnöides	Mr. Marks.
Section of Human Placenta injected	Mr. Topping.

Attendance—Members, 67; Visitors, 9; total, 76.

April 25th, 1873.—*Chairman*, Dr. R. Braithwaite, F.L.S., President.

The following donations to the Club were announced:—

"The Monthly Microscopical Journal"	from the Publisher.
"Science Gossip"	,,
"The Popular Science Review"	,,
"The Proceedings of the Royal Society," No. 143	the Society.
"The American Naturalist"	in exchange.
"Proceedings of the Literary and Philosophical Society of Manchester"	from the Society.
"Transactions and Proceedings of the Botanical Society of Edinburgh," 12 Nos. ...	the Society.
"The Journal of the London Institution" ...	the Librarian.
"The 2nd Annual Report of the South London Microscopical and Natural History Society"	the Society.
Six Slides of Spiculæ	Mr. J. G. Waller.

The thanks of the Club were unanimously voted to the donors.

Mr. Golding said that ever since he had been connected with the Club he had noticed that communications of a simple kind were always well received by the members, indeed one of his earliest reminiscences was in connection with a short paper by Mr. McIntire, descriptive of some little contrivances of his which he found useful. It was the readiness with which such simple communications had always been received which induced him to bring before the notice

of the Club a few little matters of a similar kind. It was well known that all objects which required to be examined by transmitted light needed that light to be thrown upon them in particular directions, and the proper direction for each object or part of an object could not be well ascertained unless a rotating motion were given to it. This kind of motion could not so readily be given to an object with the fingers as other motions could, and although the rotating stage had been designed for the purpose, there were many microscopes which did not possess such a stage, and the cost of adding one would be in many cases an objection to its use. Not having one to his own instrument, and having felt the want of one, he had devised a simple substitute, which he had found to answer the purpose in every respect. It consisted of a flat disc of wood, having a tube fastened to its lower side which fitted smoothly within the substage tube; when placed in position the wood disc rested evenly upon the stage of the microscope, and could be easily rotated by the fingers. The apparatus was exhibited to the meeting, and its application practically explained. Mr. Golding also exhibited and described a simple method of making a condenser by inserting a lense in a pasteboard tube; a similar method of mounting crystals of Herapathite to form a polariscope; an improvement in the stand for a portable microscope brought out by Mr. Richards; a new form of Zoophyte trough; a new pattern "finder;" and a new cement for cells, &c. He also said that he had endeavoured to trace what had become of two living diamond beetles recently exhibited at the Liverpool Microscopical Society, in the hope that they might have been exhibited also to the members of the Club. He had not, however, been successful hitherto in the matter.

The thanks of the meeting were accorded to Mr. Golding for his communication.

Mr. T. C. White said that if the cement described by Mr. Golding was the same as a transparent cement he had recently tried it would be found to contain so large a quantity of gelatine that its contraction in drying was so great as to actually pull the covering glass of a cell into four or five pieces.

Mr. Golding believed that the cement in question would not be found to do the same as that mentioned by Mr. White; he was not aware of its actual constituents, but had noticed that it had rather a tendency to gelatinize, and that it was strongly alkaline.

The Secretary said that Mr. Richards had brought to the meeting a new form of stand for his portable microscope. It differed from the ordinary kind in having the upright rod placed near to the extremity of one of the arms of the base, instead of being in the centre; the alteration had the effect of giving much greater stability to the instrument when in use.

Dr. Matthews exhibited to the meeting a new supplementary stage for obtaining oblique illumination, designed by himself and constructed by Mr. Swift. It consisted of two oblong brass plates, separated from each other by brass pillars at the corners, the upper plate formed the stage upon which objects were viewed, and the lower one had a grove cut lengthways across it in which a mount carrying a small mirror was made to traverse. The mirror was silvered upon its surfaces by the glass-silvering process, the result being greatly increased reflective power and the absence of double images. Not only could the angular aperture of an objective be measured by this apparatus, but the most perfect definition with oblique illumination had been obtained, small specimens of "Angulatum" being well shown with a $\frac{1}{5}$in. objective.

The President, in thanking Dr. Matthews for his communication, expressed

his own admiration of the little instrument which had been brought under their notice. The silvered surface as applied to microscope mirrors he thought was a valuable introduction.

Mr. Ingpen said he could vouch for the great amount of light reflected by mirrors silvered in this manner, and to the advantage of having only one reflecting surface, but he should be glad to know if the silver did not soon become tarnished, as this had been found to be the case with specula for telescopes which had been silvered in this way. There was a great difference in the films deposited; sometimes they were tolerably hard, but often they were very soft, and the silver was then very easily rubbed off. Cox and Johnson's films were generally soft ones. He had himself deposited many films by the sugar of milk process, but found that in most cases they were easily tarnished and rubbed off. His object in asking the question was the hope that some method of hardening the films might have been discovered.

Dr. Matthews said that he could not at present say much upon the point. He had not yet attempted to clean the silver surface, although he found that there was a finger mark upon it.

Mr. Locke, having had some experience as to silvered glass reflectors which had been done for him by Mr. Swift, could say that he had found them tarnish very rapidly, and the films were so soft that any attempt at re-polishing rubbed them away. He found this such an objection to their use that if he required any more he should have them made of silver plate.

Mr. Ingpen thought that silver plate would be found to answer the purpose very well. He was quite aware of the objections to glass silvering, and had asked the question now hoping to hear that some means might have been found of preserving the surface.

Mr. T. C. White could bear testimony as the value of this mode of silvering for reflecting purposes. Some time ago he used a plane mirror silvered in this way for drawing objects by inclining it at an angle of 45° with the horizontal body of the microscope, and projecting the magnified image on to the drawing paper, the reflecting surface was perfect, but he felt very much grieved to find that it so soon got tarnished. He quite agreed with Mr. Ingpen that if only some method of preserving the silver could be devised it would be invaluable for such appliances.

Mr. Ingpen said that the question was engaging the attention of several persons at the present time, and was one of some importance now that so many telescopes were being made with specula silvered in that way. When the film was first deposited it of course had to be polished, and this was done with a very fine leather and the finest rouge. Perhaps Dr. Matthews might be able to remove the finger mark from his mirror by this means; some films being much harder than others would bear more rubbing. Of course any mirror could be re-silvered at any time at a small expense.

Mr. Matthews said he had omitted to mention that he thought at first the mirror had been made too small for the purpose, but he found it in reality to be quite twice too large; it would be much better if it were made smaller. Practically one not wider that ¼in. in diameter would do quite well.

Mr. Ingpen thought there could be no doubt as to the superiority of silver surface over any other for reflecting purposes; he had some small specula belonging to Gregorian telescopes which were well polished and clean, but they bore no comparison with the silver for the amount of light which they reflected.

Mr. Ackland suggested that if Dr. Matthews would use as a reflector a double

convex lens silvered upon the back surface he would find it very effective, and very little trouble would arise from reflections from the upper surface. Such a plan was in common use on the Continent for opthalmoscopes, and was found to answer very well.

Dr. Matthews explained that his observations had only referred to the use of a plane mirror; the presence of a lens would be rather foreign to the purpose.

Mr. Ackland said of course his suggestion was for a concave mirror only; he was under the impression that Dr. Matthews had used the concave surface.

Mr. B. T. Lowne related some very interesting facts in connection with the development of certain Hymenopterous insects, illustrating his remarks by numerous diagrams and by drawings upon the black board.

The President, in proposing a vote of thanks to Mr. Lowne for his extremely interesting communication, characterised the subject as one of the greatest importance, and expressed a hope that many other persons might be induced to take up the study. Mr. Lowne had made this field so entirely his own that his remarks were sure to be received with great pleasure and interest by the members of the Club, on whose behalf he ventured to express a hope that this had only been the first of a series of similar communications.—The vote of thanks was then put to the meeting and carried unanimously.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Professor Brown's Pocket Microscope on Special Stand	by Mr. Crisp.
Balanus balanöides	Mr. Fitch.
Wing of Morpho Menelaus	Mr. Golding.
Conochilus Volvox (collected at Snaresbrook excursion, April 19th, 1873)	Mr Hainworth.
Skin of Dog Fish	Mr. Kitsell.
New Super-stage for oblique illumination ...	Dr. Matthews.
Ptilota elegans	Mr. J. C. Sigsworth.
Wing case of diamond beetle and Platino Cyanide of Magnesium	Mr. Topping.

Attendance—Members, 78; Visitors, 3.

9th May, 1873.—Conversational Meeting.

Section of Blow Fly's Eye	Mr. S. J. McIntire.
Leg of Cyphus nigro-punctatus	Mr. Oxley.
	Mr. Goodinge.
Corethra Plumicornis in different stages, larva to imago	Mr. Fitch.
Section of Ficus elastica...	Mr. Sigsworth.
Head of Cicendela Chinensis	Mr. Golding.

Members, 46; Visitors, 7.

May 23rd, 1873.—Dr. R. Braithwaite, F.L.S., President, in the Chair.

The following donations to the Club were announced:—

"The Monthly Microscopical Journal" ...	from the Publisher.
"Science Gossip"	,,
"Proceedings of the Geologists' Association ...	the Association.
"President's Address, &c., of the West Kent Natural History Society"	the Society.
"Withering's Botany," 2 vols.	Mr. Jas. Watkins.

The thanks of the Club were unanimously voted to the Donors.

The following gentlemen were ballotted for, and duly elected members of the Club:—Mr. Alfred Coles, Mr. Robert R. F. Davey, Mr. William Gregory, Mr. George C. Karop, Captain Loftus F. Jones, R.N., Mr. W. H. Kennell, Lieut.-Colonel J. C. Salkeld, Mr. James H. C. Stewart, and Dr. John Whitmore.

There being no formal paper to be read before the meeting,

Mr. T. C. White thought it might be interesting to members to know the particulars of the last mode of producing crystals of hippuric acid by means of sulphur fumes. He was induced to bring the subject before them because of a letter which he had lately received from Mr. Furlonge, in which that gentleman seemed very much struck with the method of crystallization by breathing upon a film, and in which he had also asked how the effects were produced by the sulphur fumes. The ordinary method was to make a saturated solution of the salt in absolute alcohol, which should be heated in order to cause it to take up as much as possible. Then a small quantity of the warm solution was taken up in a warm dipping tube, and placed upon a warm slide, over which it would flow evenly, and would, as it cooled, form a thin transparent film. In a short time—according to the amount of moisture in the atmosphere—crystallization would begin to start from a number of centres, and would, if not interfered with, form a number of circular crystals. But if, when the circular crystals were beginning to form they were breathed upon, a number of fringed crystals would at once begin to start from all round their edges. If, instead of breathing on them, they were put under a bell-glass with a little vapour of ammonia, fern-leaved crystals would be formed, and by varying the vapours the results would be varied accordingly. Seeing how much the form of crystal was affected by the amount of moisture brought into contact with it, he thought that if he could cover the film with something which would rapidly absorb moisture, some curious effects might result. Knowing, therefore, the power which sulphuric acid possessed of absorbing moisture, he placed the films in contact with sulphurous acid from the fumes of burning sulphur. Having covered the film with it he laid it by to cool, and found that the whole crystallized in a beautiful fern-like arrangement, but with this peculiarity—that the fronds were all of that peculiar wavy variety which had been so much admired in the specimen slides he had brought to the Club to exhibit, and which, when produced in the same way, were found to be generally constant, though there was no end to the variety produced by breathing upon them. Another curious form might be obtained by placing a glass cover over a film, and then running a little benzole round it; the crystals in this case took the form of those of uric acid, and appeared as modifications of the ordinary dumb bell crystals.

The President expressed his thanks to Mr. White for coming to the rescue on that barren evening with so interesting a communication, and invited discussion or remarks upon the subject.

Mr. Golding said he had no experience in the matter, and therefore wished to ask whether the crystals of Hippuric acid were of a permanent character, or whether they required to be mounted?

Mr. White, in reply, stated that he found the crystals were easily preserved by a very little fluid balsam run under the cover of the slide; this was all that was required. He had mounted them sometimes in castor oil, but found some difficulty in keeping the oil in. He had also tried benzole, but that was found to alter the character of the crystals altogether.

The President observed that castor oil had been long used, with success, as a preservation of crystals, but the difficulty mentioned by Mr. White of keeping it in the cell often caused inconvenience.

Mr. Alpheus Smith inquired how the square form of the crystals was produced?

Mr. White said this certainly was a very pretty form, and was much admired as a toy slide. It was produced by obtaining a film on the glass slide, and then combing it crossways with a fine comb, when the crystals started at once from all the scratches, and met in the middle of the squares. Pricking the film in different places would vary the form of the crystals; they would start from every point touched with the needle, so that a pattern of any kind could be produced. He had even caused them to form his initials by pricking the letters rapidly on the film.

Dr Matthews said that there was a method of mounting crystals in castor oil. which he had tried with success, and he thought it might be worth mentioning, After having obtained the crystals upon a glass slide, in the usual way, he placed it upon a turn-table, and taking a piece of soft wood—the end of which had been bruised a little so as to make it brushy—he cleared away all but a circular patch on the middle of the slide. He then made a cement ring or cell round the circular spot, taking care that there was a small margin left between the crystals and the cement. When this cell was properly dry, he took a glass cover and placed it nearly all over the cell, and then by means of a pipette filled the cell carefully with the oil, and slid the cover over it into its proper place. A spring clip of low power was next applied to the cover, and after all the superfluous oil had been cleared away, a ring of strong cement or gold size was run round the cover.

In reply to a question from Mr. Marks,

Dr. Matthews said that this method was of course only applicable to such kinds of crystals as castor oil would preserve. He also said that it was desirable that both the oil and the slide should be slightly warmed in order to increase the fluidity of the former.

The President reminded members that the annual meeting of the Club was approaching, and that the names of those gentlemen who were to be elected to fill vacancies on the Committee must be proposed at their next ordinary meeting; members should therefore come prepared to nominate those whom they were desirous of seeing elected. He also wished to say that several important matters had lately been engaging the attention of the Committee, which he thought it desirable to lay before the meeting. The first of these was the Journal, and with reference to this, it had been strongly felt by the Committee that in its present form it was not worth the large sum of money which it cost the Club

annually. The Committee had therefore decided to discontinue it as a quarterly publication, and to publish it either annually or otherwise, as might be found convenient, and that all papers previous to publication should be submitted to the Publishing Committee for approval. It was hoped that by this arrangement a large saving to the Club would be effected, and at the same time the real value of the papers published would not be impaired; and that the Committee, by having the papers submitted to them, would not feel obliged to publish such as might not be considered worth the expense. He also very much regretted to have to announce that they were about to lose the services of their valuable Secretary. He had that evening tendered his resignation, on account of the overwork which his duties imposed upon him in addition to his professional engagements. This announcement it was felt would be received with universal regret. In connection with it, a notice of motion had been handed in to him with reference to the appointment of a paid assistant secretary, and this would be brought forward at their next meeting in a formal manner as an addition to the bye-laws relating to the constitution of the Club. A great deal of work had now to be done of a routine character, and under present circumstances, with so large a number of members on the list, the appointment of such an officer seemed to be a necessity. These were points which he thought should be laid before them, and which he trusted would meet with general approval amongst the members.

Mr. Richards suggested that perhaps Mr. White might be induced to retain his position as secretary if he had the assistance of a paid secretary to take the heavier portion of the duties.

Mr. White said he felt much obliged to Mr. Richards for his proposal, but he felt obliged to decline it. He could assure the members that it was with no slight pang that he gave up his position amongst them, for he loved the club, and had done so ever since he joined its ranks, and he looked upon its progress with no little pride. They had now upon the list 570 *bona fide* members, and although this number was perhaps not a very large increase upon that which appeared in the reports some time ago, yet it did in reality represent a very much stronger body of members. On going over the list he had found that a great many names had been placed upon the roll irregularly; the parties disowned their connection with the club, and said they had been elected without their consent; others had not kept up their subscriptions, and so forth. All such names had now been weeded out, and the number now on the books consisted of good, *bona fide* paying members. And when they had such a large club as that they would easily see that there was a great deal to be done, many letters to be answered, and other matters to see to. This work, added to the heavy work of an increasing practice in his profession, he found too much for him, and he felt that he was not able, under the circumstances, to do his duty to the club as he should wish it to be done, and therefore he felt he ought to give it up. He would, of course, do all in his power to assist his successor in the work, and he hoped that the members would bear in mind that although he should cease to be their secretary he was not going to leave the club, and that he hoped with an increased amount of time at his disposal to be able to do more than he had done in the way of papers or communications.

The Secretary announced that the whole of the slides in the cabinet (upwards of 2,000) had been thoroughly overhauled and re-arranged, and that they would now be again available to the members, under the usual regulations.

Announcements of meetings for the ensuing month having been made, and special attention having been called to the Annual Dinner of the club, which

was arranged to take place at Leatherhead on June 19th, the proceedings terminated with a conversazione, at which the following objects were exhibited:—

A cheap form of Hand Spectroscope	by Mr. Burch.
Eyes of *Tabanus*—opaque, in balsam	Mr. Curties.
Parasite of Spider	Mr. Freeman.
Stephanoceros Eichornii, and *Melicerta* (alive) ...	Mr. Hainworth.
Sections of Rush	Mr. B. D. Jackson.
Ambulacral disc of *Echinus Lividus*	Mr. Pett.
Lung of Boa Constrictor—injected	Mr. Topping.
Trachea of *Hydrophilus Caraboides*	Mr G. Williams.

Attendance—Members, 75; Visitors, 9. Total, 84.

13th June, 1873.—Conversational Meeting.

Objects Exhibited.

Vertical section of Oncidium luridum (stained with Logwood)	Mr. B. D. Jackson.
Section of Eye—Hoverer Fly	Mr. S. J. McIntire.
Exuvia of Spider	Mr. Fredk. Fitch.
Tongue of Young Epeira	,,
Marine Algæ	Mr. Thos Curties.
Small Intestine injection—mounted by the late J. Quekett	Mr. E. Bartlett.
Hunting Spider	Mr. G. Williams.
Parasite of Bat	Mr. E. P. Pett.
Section of Ear of Rabbit (stained with carmine)	Mr. F. Oxley.
Section of Nose of Dog—transparent injection	Mr. A. Topping.
Blue-bottle Fly	Mr. W. H. Golding.

Members, 53; Visitors, 2. Total, 55.

27th June, 1873.—Conversational Meeting.

Series of Sections of Echinus Spines	Mr. Pett.
Section of Medulla Oblongata of Mouse (injected)	Mr. Topping.
Lasiöpetalum Solanaceum	Mr. Watkins.
Sponge (?) on Shell from Mauritius	Mr. Ingpen.
Section of Blow-Fly (opaque)	Mr. J. A. Smith.
Plumatella hatched from Statoblasts obtained at Victoria Docks, 1872	Mr. Hainworth.
Currant Hawk-Moth (Trochilium tipuliforme), alive...	Mr. G. Williams.

Attendance—Members, 58; Visitors, 6.

On the Characteristics of Certain of the Hymenoptera.

By B. T. Lowne, F.R.C.S., F.L.S., &c.*

Delivered April 25th, 1873.)

The subject which I am about to bring before you this evening is not one of original research; nevertheless, it is one of such very great interest, and also of such extreme importance, and is one so little known in this country, that I feel myself fully justified in bringing it before you. It appeared in the first instance about five years ago, in a German periodical, "Kolliker's Zeitschrift fur Wissenschaft eiche Zoologie." It will, perhaps, be said that this being the case, it is very late now to bring it before you; but so great is the interest and importance which attaches to it, that I feel sure I shall be justified in doing so, and the more so because it opens up a very wide field of research to those who choose to enter upon the subject. The creatures to which I am about to refer are some of them very well known to all of us; specimens have from time to time been brought here for exhibition by Mr. Fitch, consisting of minute Hymenopterous insects which he had found in spider's webs. They belong to the same class as the bees, the wasps, and the Ichneumons—a class which comprehends the whole of the 4-winged flies, is exceedingly numerous, and for the most part exceedingly minute, so that probably nine-tenths of the whole number are scarcely visible to the naked eye. Amongst the most remarkable characteristics of this group of insects is the fact that nearly the whole of them are parasitic. The Ichneumons, for instance, lay their eggs in the bodies of caterpillars, and when the caterpillar in which an egg has been laid has been transformed into a chrysalis the egg hatches the larva of the ichneumon, eats up the chrysalis, goes through its own transformations, and by-and-bye there emerges, not a buttterfly but an ichneumon.

* The facts recorded in this paper are from M. Ganin Beitrage zur Erkeuntniss der Entwickelungsgeschichte beiden insecten, "Koll. Zeit. fur Wissensch. Zool.," Band xix., p. 381.

All this is very remarkable, but the forms which I am going to describe are more remarkable still, for they are not only parasitic, but they prey upon one another. In size they are scarcely visible to the naked eye, they would in fact only look like grains of small dust. I am going to bring under your notice some facts and observations of extreme interest in relation to the development of three genera, all the species of which are parasitic, and all of which have fringed wings, characteristics, however, I believe, common to a vast number of genera in this class of Hymenoptera.

The first genus which I shall describe is known as Platygaster, and in tracing up its development I shall begin with the egg. The eggs of most of these curious little Hymenoptera are enclosed in an envelope which has a small pedicle attached to it; they are of course exceedingly minute, are transparent, and contain no food yolk. In the bird's egg, it will be remembered, there is a large yolk, and there is also a portion known as the tread or cicatricula. This is the true germinal spot of the egg; it is living matter, and the food yolk feeds this little piece of protoplasm during the process of development. Moreover, in the case of a large number of worms the egg is formed of a union of two kinds of yolks secreted by different glands and only united in the egg; but the eggs of these flies contain no food yolk, only a protoplasmic yolk, and the reason for this is explained by their curious mode of development.

In the course of development, we first find that the single cell is broken up into three cells, and a very curious thing is that the central cell begins to form young cells inside it, and that the other cells form an envelope round the central cell. We may look upon this as the formation of the first shed skin of the creature. Whilst this is taking place, large cells are being formed in the interior of the central cell; from these the larva of platygaster is developed.

The eggs of Platygaster are laid in the body of the larva of one of the diptera, *Cecidomyia*, in which it undergoes the process of development. It is at first a solid mass of protoplasm, as there is no central fluid food yolk, but after the above-described changes, the central mass of cells becomes inflected precisely in the same manner as the embryo becomes folded in the course of the development of the egg of the lobster or crawfish, and, as in the case of the crawfish, one side of the depression forms the head and the other the tail. This change goes on until at last an embryo is formed, bearing a strong resemblance to a rudimentary crustacean,

then the portion which represents the tail becomes split into two, and at length three pairs of lateral appendages are formed as buds, whilst a pair of longitudinal bristles spring from the tail. In the meantime a hollow has been formed in the interior, which will become the alimentary canal.

The egg now hatches, the larva comes out, and swims about in the interior of the host. On referring to Mr. Ganin's figures, which have been reproduced in "Nature" since this paper was read, you will, I think, at once see the resemblance which this larva bears to an ordinary cyclops, and it certainly bears a very curious resemblance to several forms of crustacea. Three or four of the eggs are generally laid in the body of one cecidomyian larva, and when the host has been destroyed by them and no more remains to be eaten, they fall to upon one another; the weakest goes to the wall, until at last there is only one left. There is still only a very rudimentary alimentary canal; the whole creature, in fact, remains very rudimentary up to this stage of development.

The cellular walls of the embryo-platygaster now begin to undergo differentiation, and the changes which take place are very like those which take place in the blastoderm of an ordinary insect's egg. In fact, this cyclops-like larva may be looked upon as a kind of living egg shell, in the interior of which a new creature is being developed. This may at first appear so strange as to be incredible, but similar instances of such development are well known; an excellent example of this phenemonon is seen in the case of the common star-fish. In its early stage it is called a Pluteus, and it is in the interior of this larva or embryo that the star-fish undergoes development, by the growth and development of new formed embryonic cells. To recur to our Platygaster, the next change consists in the shedding of the cyclops-like integument, and the new embryo becomes remarkable for its entire want of segmentation, so that it looks more like one of the lower forms of worms. After this a further change takes place, a new skin is again formed, which this time is entirely hymenopterous; the creature has now become a thoroughly hymenopterous larva, and having passed through the usual transformations emerges at length as a perfectly formed Platygaster. This is certainly an extremely curious and remarkable life history, and one which I believe will one day throw much light upon the question of the evolution of insects. The curious resemblance in the course of

development to certain forms of crustacea is a point of the greatest interest, and I look forward to some future researches yet to be made to throw much light upon the origin of insects.

Curious as the life history of Platygaster is, a yet more marvellous one has to be told. Some years ago Sir John Lubbock found a remarkable little hymenopterous insect, which used its wings for the purpose of swimming under water, belonging to the genus Polynema. The eggs of Polynema are very much like those of Platygaster; but they are laid not in the larva of another insect, but in the egg. The adult Polynema seeks for suitable eggs and deposits her own with them. The eggs thus chosen are those of the beautiful green dragon fly, *Agrion Virgo*, which lays its eggs in the buds of the water-lily. A group of cells united together into a solid mass escapes from the egg of Polynema, which hatches, in fact, as a protoplasmic yolk, which appropriates the food yolk of the egg of another creature. At an early period the egg of the dragon fly ceases in its development, but that of the Polynema goes on until a larva is produced, which resembles in appearance one of the lower Annelids; this too undergoes changes similar to those observed in the case of Platygaster, and ultimately forms a larva just like an ordinary hymenopterous larva, except that it never forms any tracheæ, and remains entirely without any such organs during the whole of its life. The Dragon-fly's egg shell becomes now only a kind of case in which the development of Polynema goes on. After a few days the egg shell is broken, but instead of a larval Dragon fly, there emerges an adult Polynema, which dives at once into the water. The wings may be fairly believed to subserve the respiratory function in these insects, as they remain open sacs, the interior of which is continuous with the body cavity of the insects. It is interesting to remember that Oken believed the wings of insects to be modifications of respiratory organs, and homologous with the main tracheal trunks. I do not know if, at this late period of the evening, I should be justified in entering into the details of the history of the other form of genus Ophioneurus, which I alluded to at the outset of this paper. There are some differences between its development and that of Platygaster and Polynema. I will only mention the more important of these. Ophioneurus is aërial instead of aquatic; it is parasitic in the eggs of the common cabbage butterfly, and is, therefore, probably an easy form to obtain. Instead of

a single larva only being developed in each butterfly's egg, several are sometimes perfected in it. The young embryo escapes in an unformed condition, like polynema, but remains attached to its ruptured egg-shell; this embryo becomes converted directly into an unsegmented larva without any skin shedding, thus differing from the types I have already described. The whole developmental process is simpler than in Polynema or Platygaster, but as in those genera the embryo becomes converted into a larva by the gradual development of structures similar to those which are usually developed in the egg, a primitive fold and head lappets appear, as in crustacean and insect embryos, although the larva soon assumes a simple sac-like form. Soon, however, the hypodermis, or lower layer of the skin of this sac-like larva becomes converted into imaginal discs, and these, strange to say, form the outer integument of the perfect form, and are never shed. All these changes take place very rapidly, and in two or three days the infected eggs produce from one to three perfect Ophioneuri, instead of a single lepidopterous larva.

I do not know whether it will ever be possible for me to find time to trace out the wonderful changes described by Herr Ganin, but I feel sure that great additional light will be one day thrown upon the affinities of insects by the study of these wonderful life histories, and I doubt not that thousands of infected lepidopterous and other eggs might be found by anyone who has the skill and leisure to prosecute this research, and that the labour would be repaid by the richest results.

Collecting and Preserving Fresh Water Algæ.

By Dr. Horatio Wood, Jun.*

There are three or four distinct classes of localities, in each of which a different set of forms may be looked for. These are stagnant ditches and pools, springs, rivulets, large rivers, and other bodies of pure water, dripping rocks in ravines, &c.; trunks of old trees, boards, branches and twigs of living trees, and other localities.

In regard to the first—*stagnant waters*—in these the most conspicuous forms are Oscillatoriæ and Zygnemaceæ. The Oscillatoriæ may almost always be recognised at once by their forming dense slimy strata, floating or attached, generally with very fine rays extending from the mass, like a long, delicate fringe. The stratum is rarely of a bright green colour, but is mostly dark, dull greenish, blackish, purplish, blue, &c. The Oscillatoriæ are equally valuable as specimens at all times and seasons, as their fruit is not known, and the characters defining the species do not depend upon sexual organs. The Zygnemas are the bright green, evidently filamentous, slimy masses, which float on ditches, or lie in them, entangled amongst the water plants, sticks, twigs, &c. They are only of scientific value when in fruit, as it is only at such times that they can be determined. Excepting in the case of one or two very large forms, it is impossible to tell with the naked eye with certainty whether a Zygnema is in fruit or not; but there are one or two practical points, the remembrance of which will very greatly enhance the probable yield of an afternoon's search. In the first place the fruiting season is in the spring and early summer, the latter part of March, May, and June being the months when the collector will be best repaid for looking for this family. Again, when these plants are fruiting they lose their bright green colour and become dingy, often yellowish, and very dirty looking—just such specimens as the tyro would pass by. The fine, bright green,

* Extracted from "A Contribution to the Natural History of the Fresh Water Algæ of America." Washington, 1873.

handsome masses of these algæ are rarely worth carrying home. After all, however, much must be left to chance; the best way is to gather small quantities from numerous localities, keeping them separate until they can be examined.

Adhering to the various larger plants, to floating matters, twigs, stones, &c., in ditches, will often be found filamentous Algæ, which make fine filmy fringes around the stems, or on the edges of the leaves, or perchance one may meet with Rivalariæ or Nostocs, &c., forming little green or brownish balls, or indefinite protuberances attached to small stems or leaves. These latter forms are to be looked for, especially late in the season, and whenever seen should be secured.

In the latter part of summer there is often a brownish, gelatinous scum to be seen floating on ditches. Portions of this should be preserved, as it frequently contains interesting Nostocs and other plants.

In regard to *large rivers*, the time of year in which I have been most successful in such localities is the latter summer months. *Springs* and small bodies of clear water may be searched with a hope of reward at any time of the year when they are not actually frozen up. I have found some exceedingly beautiful and rare Algæ in such places as early as March, and in open seasons they may be collected even earlier than this. The Desmids are most abundant in the spring, and possibly most beautiful then. They, however, rarely conjugate at that time, and the most valuable specimens are therefore to be obtained later—during the summer and autumn months, at least, so it is said; and the experience I have had with this family seems to confirm it. *Rivulets* should be watched especially in early spring, and during the summer months.

From the time when the weather first grows cool in the autumn, on until the cold weather has fairly set in, and the reign of ice and snow commences, is the period during which the Algæ hunter should search carefully all wet, *dripping rocks*, for specimens. Amongst the stems of wet mosses—in dark, damp crevices, and little grottos beneath shelving rocks—is the Algæ harvest to be reaped at this season. Nostocs, Palmellas, conjugating Desmids, Sirosiphons, various unicellular Algæ, then flourish in such localities. My experience has been that late in the autumn ravines, railroad cuttings, rocky river-banks, &c., reward time and labour better than any other localities.

The Vaucherias, which grow frequently on wet ground, as well as submerged, fruit in the early spring and summer in this latitude, and are therefore to be collected at such times, since they are only worth preserving when in fruit.

In regard to Algæ which grow on trees, I have found but a single species, and do not think they are at all abundant in this latitude. Further south, they seem to be the most abundant forms.

As to the preservation of Algæ, most of the submerged species are spoiled by drying. Studies of them should always, when practicable, be made whilst fresh. Circumstances, however, will often prevent this, and I have found that they may be preserved for a certain period, say three or four months, without very much change, in a strong solution of acetate of alumina.

An even better preservative, however, and one much more easily obtained, is carbolic acid, for I have studied Desmids with great satisfaction which had been preserved for five or six years in a watery solution of this substance. In regard to the strength of the solution, I have no fixed rule, always simply shaking up a few drops of the acid with the water, until the latter is very decidedly impregnated with it, as indicated by the senses of smell and taste.

Almost all species of Algæ which are firm and semi-cartilaginous, or almost woody in consistency, are best preserved by simply drying them, and keeping them in the ordinary manner for small plants. The fresh-water Algæ which bear this treatment well belong to the *Phycochromophyceæ*, such as the *Nostocs*, *Scytonema*, &c., the true confervas not enduring such treatment at all. When dried plants are to be studied, fragments of them should be soaked for a few minutes in warm, or for a longer time in cold water.

The only satisfactory way that Algæ can be finally prepared for the cabinet is by mounting them whole or in portions, according to size, for the microscope. Of the best methods of doing this the present is hardly the time to speak ; but a word as to the way of cleaning them will not be out of place. Many of them, especially the large filamentous ones, may be washed by holding them fast upon an ordinary microscope slide, with a bent needle, or a pair of forceps, and allowing water to flow or slop over them freely, whilst they are rubbed with a stiffish camel's-hair pencil or brush. In other cases, the best plan is to put a mass of the specimens in a

bottle half-full of water, and shake the whole violently, drawing off the water from the plants in some way, and repeating the process with fresh additions of water, until the plants are well scoured. At first sight, this process would seem exceedingly rough, and liable to spoil the specimens, but I have never seen bad results from it, at least when practised with judgment. The water seems so to envelope and protect the little plants, that they are not injured.

After all, in many instances it appears impossible to clean these Algæ without utterly ruining and destroying them, so that he who despises and rejects mounted specimens simply because they are dirty and unsightly, will often reject that which, scientifically speaking, is most valuable and attractive.

In finally mounting these plants, the only proper way is to place them in some preservative solution within a cell on a slide. After trial of solution of acetate of alumina and various other preservative fluids, I have settled upon a very weak solution of carbolic acid, as the best possible liquid to mount these plants in. Acetate of alumina would be very satisfactory were it not for the very great tendency of the solution to deposit minute granules, and thus spoil the specimens. As every one knows, the great difficulty in preserving microscopic objects in the moist way is the perverse tendency of the cells to leak, and consequently slowly to allow entrance to the air and spoil the specimens.

As I have frequently found to my great chagrin, the fact that a slide has remained unchanged for six months, or even a year, is no guarantee that it will remain so indefinitely. It becomes, therefore, exceedingly important to find some way of putting up microscopic objects that can be relied on for their preservation. Where carbolated glycerine jelly or Canada balsam can be used, the solid coating which they form around the specimens constitutes the best known protection. Except in case of the Diatoms, however, these substances so shrivel and distort the fresh water algæ immersed in them as to utterly ruin them. I lost so many specimens by the old ways of mounting, that, becoming disheartened, I gave up all idea of making a permanent cabinet, until a new cement, invented by Dr. J. G. Hunt, of this city, was brought to my notice. This is prepared as follows:—

Take damar gum, any quantity, and dissolve it in benzole; the solution may be hastened by heat. After obtaining a solution just

thick enough to drop readily from the brush, add enough of the finest dry oxide of zinc, previously triturated in a mortar with a small quantity of benzole, until the solution becomes white when thoroughly stirred. If not too much zinc has been added, the solution will drop quickly from the brush, flow readily, and dry quickly enough for convenient work. It will adhere, if worked properly, when the cell-cover is pressed down, even when glycerine is used for the preservative medium. Keep in an alcohol lamp bottle with a tight lid, and secure the brush for applying the cement in the lid of the bottle.

Its advantages lie in the circumstance that the glass cover can be placed upon the ring of it whilst still fresh and soft, and that in drying it adheres to both cover and slide, so as to form a joint between them of the width of the ring of cement, and not, as with asphaltum, gold size, &c., simply at the edge and upon the outside of the cover. It is readily to be seen how much less liability to leakage must result from this. The method of mounting with it is as follows:—A ring of any desired size is made by means of an ordinary Shadbolt's turn-table, upon a slide, which is then placed to one side to dry. When required for use, the specimen, cover, &c., being all prepared and ready, the slide is again placed upon the turn-table, and a new ring of cement put directly upon the old one. The specimen is immediately placed within the cell thus formed, and the requisite quantity of the carbolated water placed upon it. The cover, which must be large enough to entirely or nearly cover the cement ring, is now picked up with the forceps, the under side being moistened by the breath to prevent adhesion of air-bubbles, and placed carefully in position. It is now to be carefully and equably pressed down with some force. By this any superfluous water is squeezed out, and the cover is forced down into the cement which rises as a little ring around its edge. The pressure is best made with a stiff needle, at first on the centre, and then upon the edges of the cover, which may finally be made slowly to revolve underneath the needle point. The slide may then be put aside to dry; or better, an outside ring of the cement thrown over its edge in the usual manner. Where a deep cell is required, several coats of the cement should be placed one over the other, each being allowed to dry in turn. If time be an object, and only a shallow cell be necessary, the first ring of cement may be dispensed with, and the whole mounting of the specimen be done in a few

minutes. Even with this cement, and the utmost care in mounting, the cabinet should be occasionally inspected, for there will always be some slides into which air will penetrate. When such are found efforts may be made to stop the leak by new rings of cement overlaid upon the old; but very often entire remounting of the specimen is the only satisfactory cure.

SPILOCÆA POMI. *Fries.*

This cosmopolitan fungus has made its appearance this autumn in what would seem to be stronger force than heretofore, threatening some crops with destruction. It appears at first beneath the cuticle of the fruit, then breaks through in circular, often confluent, patches, of a dark brown colour, bordered by the lacerated margin of the cuticle. The microscope reveals a mass of short septate threads, which are simple, and closely packed together, each one terminating in an ovate, caducous joint, which has all the characters of a spore, and ultimately becomes at least uniseptate. The threads and spores are slightly coloured of a smoky-grey tint. From these particulars it will be seen how near *Spilocæa pomi* approaches to such species of *Cladosporium* as *C. dendriticum*, of which it is probably only a condition. In the "Gardener's Chronicle" for Sept. 20th, it is supposed to be a state of *Helminthosporium pyrorum*. At any rate, mycologists seem to be agreed that it is not an autonomous plant, and is closely related either to *Cladosporium* or *Helminthosporium*. From our own examination, we are at present more disposed to refer it to the former than to the latter. Further investigation, at a later period, might, perhaps, modify this opinion, but at present its characters seem to approximate so closely to *Cladosporium dendriticum*, especially the variety *orbiculatum*, that we consider the probabilities strongly in favour of that species.—M. C. Cooke.

NOBERT'S TESTS AND MR. WEBB.

The following letter has been received from Dr. Woodward:—

Army Medical Museum,
Washington, D.C., August 18th, 1873.

To the Members of the Quekett Microscopical Club.

GENTLEMEN,—As I always read the Journal of your Club with interest, my attention was at once arrested by the communication of Mr. William Webb "on Nobert's Tests," in the July number, in which he arrives at the conclusion "That beyond the first few bands of Nobert's Tests there is not one containing a line properly so called." The mechanical considerations urged by Mr. Webb I will not discuss further than to say that he appears to have overlooked completely one of the most striking facts with regard to Nobert's plates, viz.: That the lines of the first band are not only further apart, but are more deeply ruled than those of the second; that those of the third are still shallower, and so on progressively. This circumstance, it appears to me, destroys his whole argument.

I do not, however, write to discuss Mr. Webb's argument, but to remind the members of the club that there is a physical reason which compels us to believe that the first fifteen bands, at least, of the nineteen band plate are composed of real and distinct lines, and that the distance of these lines apart must approximate very closely to what was intended by Nobert.

When the bands of the Nobert's plate are illuminated by oblique light, and are looked at from above with a low power (too low to show any of the lines), each band appears as a smooth coloured stripe. From the known wave length of the colour seen, and the angle of the incident pencil, the distance which the lines of any band must actually be apart can be computed by the well-known formula for the spectrum of gratings enunciated by Fraunhofer, and the distance thus obtained agrees with that at which Nobert ruled the lines. On the other hand the angle of the incident pencil being known, and Nobert's given distance being assumed to be

true, a table of wave lengths for the different colours may be calculated, and the wave lengths thus deduced agree substantially with those computed by other means. Nobert has discussed the whole subject in two elaborate papers in the 58th volume of Poggendorff's Annalen (1852), to which I would refer any of your members who are interested in the mathematical aspects of the question. His discussion leaves, as I think, no room for the possibility of a doubt of the objective reality of the lines up to the fifteenth band.

Now I call attention to the fact that this reason is altogether independent of our ability to resolve the lines with the microscope. In fact, it enabled Nobert to know that his plates were correctly ruled long before the resolution of any but the coarsest bands had been effected by anyone; so that all that Mr. Webb's paper proves is that he does not know how Nobert produces the results, and notwithstanding his great skill in writing on glass, cannot do the same thing himself.

As no spectral colour is obtained in the bands finer than the fifteenth, the formula of Fraunhofer cannot be applied to them. In fact, the formula demonstrates that if these bands are actually ruled, as claimed, they can give no spectral colour. For my own part, however, I have no hesitation in expressing the opinion that the four higher bands (16th, 17th, 18th, and 19th) have also an objective reality I base this opinion upon the comparison of their optical appearances as seen with the best glasses with the appearances of the lower bands (especially those from the 9th to the 15th). These appearances are quite the same in both cases, and as similar results follow similar causes, I infer the existence of real lines in the four higher bands, since I know beyond the possibility of a doubt that they exist in the others. I have discussed the appearances referred to, and the whole matter of the spurious lines which are observed under certain circumstances in connection with the true lines, or instead of them, in the "Monthly Microscopical Journal" for May, 1871. Mr. Webb imagines the real lines also to be spurious, speaks of them as "aërial polarized black lines of light" (whatever they may mean), and talks generally of the part he supposes polarized light to play in the production of the phenomena, in a way which shows his optical notions to be original rather than sound. It is hardly worth while to discuss this part of his paper.

I may mention here, as a matter of interest to the club, that I

have recently examined two new test plates by Nobert—the first ruled for Professor Barnard, of Columbia College; the second for the Army Medical Museum—in which the maker has attempted to rule lines twice as fine as those of the nineteenth band. These plates have twenty bands. The first ten correspond respectively to the 1st, 3rd, 5th, 7th, 9th, 11th, 13th, 17th, and 19th of the old plate. The lines in the second group of ten bands purport to be ruled at the following distances apart:—The 11th band $\frac{1}{11000}$ of a Paris line, the 12th band $\frac{1}{12000}$, and so on up to the 20th band, lines of which are said to be $\frac{1}{20000}$ of a Paris line apart. As I have not yet been able to resolve any of these new bands I will not at present express an opinion as to whether Nobert has actually succeeded in ruling them as attempted.

Finally, I would say that my attention having been directed to the accounts of Mr. Webb's fine writing on glass, which appears to be almost as marvellous in its way as Nobert's work in its, I have written to Mr. Webb requesting him to prepare a specimen for the museum. I anticipate both pleasure and instruction from its examination, and have no doubt that I shall find as much to admire in his work as I do to condemn in his arguments.

With high consideration,

J. J. WOODWARD, U.S. Army,

Honorary Foreign Member.

PROCEEDINGS.

June 27th, 1873.—*Chairman*, Dr. R. Braithwaite, F.L.S., President.

The minutes of the preceding meeting were read and confirmed.

The following donations to the Club were announced —

"The Monthly Microscopical Journal"...	from the Publisher.
"Science Gossip"	" "
"Proceedings of the Royal Society," No. 141... ...	the Society.
"The American Naturalist"	in exchange.
"The Lens"...	" "
"Proceedings of the Literary and Philosophical Society of Manchester"	from the Society.
Nineteen slides	Mr. Jas. Watkins.
Twenty-four slides	Mr. T. C. White.
£3 for the purchase of Books for the Library ...	Mr. Henry Horncastle, of Whitmore, Notts.

The thanks of the Meeting were unanimously voted to the donors.

The following gentlemen were ballotted for and duly elected members of the Club :—Mr. Alfred S. Corbitt, Mr. H. G. Glasspool, Mr. Thomas Mason, Mr. B. W. Priest, Mr. G. R. B. Ray, Mr. Frederick Reeve, Mr. Joseph E. Symons, Mr. G. J. Smith, and Mr. Edward Souter.

Dr. G. W. Royston-Pigott read a paper entitled, " A Description of the New Interference Markings in Lepisma and Podura." The subject was illustrated by diagrams.

A vote of thanks was unanimously passed to Dr. Pigott for his paper.

Mr. S. J. McIntire said that he had only seen Dr. Pigott's exhibition once, and that was at his own house. It certainly struck him on that occasion that Dr. Pigott was a most skilful manipulator with high powers. He had himself worked a great deal at Podura scales, and in endeavouring to understand their structure he had thought it well to obtain as much knowledge as possible of the structure of insects' scales generally In examining a large number of them for this purpose, his conviction was strengthened that with high powers there was the greates difficulty in deciding what was really seen. With regard to the beads which had been described, he had frequently seen them, but at the same time he doubted their actual existence. There was in the structure of some scales a deposit of a fatty substance, and it was quite possible that this might exist in those of the Podura, and might give rise to some such appearances, although he thought it was more probably a result of interference. Dr. Pigott was the first to discover and draw attention to these appearances, and he was understood to believe in their entity, and that the club-shaped markings were illusions. He (Mr. McIntire), on the contrary, believed that the club-shaped

markings were realities. Dr. Pigott could do much with high powers, but in his own mind the doubt still remained as to what could really be done with them.

Dr. Pigott thought that, of course, everyone had a right to hold his own opinion; but the question before them was not a matter for argument, but of seeing. He had within the last two or three days hit upon a way of viewing these objects, and if ever he saw a string of red currants, why he could see those beads. It was very easy to test whether a body seen was spherical or not, for if it was so a symmetrical shadow would be found on every side when it was manipulated. He had shown these bodies to a number of persons—to a young lady, and to a deaf and dumb man, who had never heard what they were, and they both described them as beads. He had shown them to Mr. Bowman (who was present in that room), and he could describe them. Of course, every gentleman, who has his own ideas, like a true John Bull, would be very slow to believe in any new notions; but if Mr. McIntire would call upon him with any half-dozen other gentlemen, he would put the matter to the test before them.

Mr. McIntire said he did not at all doubt that these appearances could be shown, because he had seen them himself.

The chair having been taken *pro tem.* by Dr. Matthews,

The President read the second of his series of papers on "Plant Organization," in which he treated of the origin and growth of the plant cell, illustrating the subject by a number of lithographed drawings, which were handed round for the inspection of the members.

A vote of thanks to Dr. Braithwaite for his paper was then unanimously passed.

Dr. Pigott wished to ask Dr. Braithwaite if he would not take up the subject of spontaneous generation in connection with this subject; he thought it would be very interesting.

Dr. Braithwaite said he had neither the time nor opportunity for following out this subject; he might, however, say that he was not a believer in spontaneous generation, and he thought that all the most recent researches in that direction agreed in proving that it had no existence in facts.

Mr. Ingpen thought that the greatest value of such a paper as Dr. Braithwaite's would be in its educational character, inasmuch as it brought before the club certain points which, from an educational point of view, it was highly necessary should be well understood by all. He was very glad that the subject had been brought before them in this form, and that the members would be able to read it for themselves in their own journal, as a part only of a series of similar papers. Dr. Braithwaite said this was really his object in bringing forward the subject.

Mr. James Smith exhibited to the meeting a neat form of paper sunlight reflector which he had found very useful in obtaining a good and white reflected light when working with the microscope in the day time. It was intended to be hung in any convenient position in direct sunshine, and the mirror of the instrument directed towards it.

A vote of thanks was passed to Mr. Smith for his communication.

The Secretary read a letter which had been received by Mr. Golding from Mr. Chantrell, of Liverpool, describing a series of observations recently carried on in connection with the development of certain Infusoria in glass troughs constructed for the purpose.

Mr. B. D. Jackson gave notice that at the next meeting he would propose a

new bye-law to be substituted for the 2nd bye-law now in force, relating to the officers of the club. The proposed new bye-law having been read to the meeting, the President intimated that it would be submitted for approval or otherwise at the Annual Meeting in July.

The President then reminded the members that the next time they met would be the occasion of the Anniversary of the Club, and invited nominations of gentlemen to fill vacancies upon the Committee.

The following gentlemen were then nominated as Vice-Presidents for the ensuing year:—

Mr. T. W. Burr	Proposed by	Mr. Hind	Seconded by	Mr. G. Williams.
Mr. B. T. Lowne	,,	Mr. B. D. Jackson	,,	Mr. Hainworth.
Dr. Matthews	,,	Mr. Hainworth	,,	Mr. Pett.
Mr. Chas. F. White	,,	Mr. Ramsbotham	,,	Mr. Marks.

The following gentlemen were nominated as members of Committee:—

Mr. E. Bartlett	Proposed by	Mr. Jas. Smith	Seconded by	Mr. E. Richards.
Mr. W. M. Bywater	,,	Mr. J. A. Smith	,,	Mr. Pett.
Mr. Frank Crisp	,,	Mr. Jas. Watkins	,,	Mr. Kitrill.
Mr. H. F. Hailes	,,	Mr. Curteis	,,	Mr. E. George.
Mr. F. H. P. Hind	,,	Mr. Alpheus Smith	,,	Mr. T. Terry.
Mr. Jas. Nelson	,,	Mr. J. G. Waller	,,	Mr. A. Waller.
Mr. E. T. Newton	,,	Mr. E. P. Pett	,,	Mr. J. A. Smith.
Mr. J. G. Waller	,,	Mr. Hailes	,,	Dr. Matthews.
Mr. T. C. White	,,	Mr. E. Richards	,,	Mr. Jas. Smith.

To fill the office of Auditor on behalf of the Club—

Mr. Pett was proposed by Mr. Curteis, seconded by Mr. J. A. Smith, and unanimously elected.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Plumatella	by Mr. Hainworth.
Sponge on a Shell from Mauritius	Mr. Ingpen.
Sections of Echinus Spines	Mr. Pett.
Polished Slab of Oolite	Mr. Sigsworth.
Section of Blow Fly	Mr. J. A. Smith.
Injected Section of Medulla Oblongata of Mouse	Mr. Topping.
Lasiopetalum Solanaceum	Mr. Watkins.
Currant Clearwing Moth (*Sesia Tipuliformis*)	Mr. G. Williams.

Attendance—Members, 59; Visitors, 5.

ANNUAL MEETING.

JULY 25th, 1873.—*Chairman*, DR. R. BRAITHWAITE, F.L.S., &c.

The minutes of the preceding meeting having been read and confirmed,

Mr. B. D. Jackson, in accordance with notice given at the last ordinary meeting, moved—"That the 2nd bye-law of the Club be abrogated, and that the following be substituted for it, viz., 'That the business of the Club be conducted by the President, four Vice-Presidents, Treasurer, Honorary Secretary, Honorary Secretary for Foreign Correspondence, and a committee of twelve other members. Six to form a quorum. That the President, Vice-Presidents, Treasurer, and two Secretaries, with four senior members of the committee (by election), retire annually, but be eligible for re-election. That the committee may appoint a stipendiary assistant secretary, who shall be subject to its direction.'" Mr. Jackson explained that the rule now proposed was the same

in effect as the one for which it was to be substituted, but it gave in addition power to the committee to appoint a paid assistant secretary, and it also omitted the clause by which the Editor of the Journal was appointed an *ex-officio* member of the committee. It had been decided to discontinue the Journal in its present form, and the editor's work would in future be carried on by a sub-committee appointed for the purpose.

Mr. Oxley seconded the resolution, and on being put to the meeting it was declared to be carried unanimously.

The Secretary read the Eighth Annual Report of the Committee of the Club, also the Treasurer's statement of accounts.

The President moved—"That the reports now read be received and adopted, and that they be printed and circulated amongst the members."

The proposal having been seconded was put to the meeting and carried unanimously.

The President also moved—"That the cordial thanks of the Club be presented to the Council of University College for their continued liberality and kindness in permitting the meetings of the Club to be held in that building."

Mr. Ingpen seconded the motion, which was then put to the meeting and carried by acclamation.

A Ballot was then taken for the election of officers and six members of the committee, Mr. Crook and Mr. Reeves having been appointed scrutineers.

The Scrutineers having handed in their report, the following gentlemen were declared to have been duly elected:—

As President ...	Dr. R. Braithwaite.
As Vice-Presidents ...	Mr. T. W. Burr. Mr. B. T. Lowne. Dr. Matthews. Mr. Chas. F. White.
As Members of Committee ...	Mr. W. M. Bywater. Mr. Frank Crisp. Mr. H. F. Hailes. Mr. F. H. P. Hind. Mr. J. G. Waller. Mr. T. C. White.
As Treasurer ...	Mr. R. Hardwicke.
As Hon. Secretary ...	Mr. J. E. Ingpen.
As Hon. Secretary for Foreign Correspondence	Dr. M. C. Cooke.
As Assistant Secretary ...	Mr. E. Marks.

The President then read his Annual Address, in which, after congratulating the members upon the continued prosperity of the Club, he gave a *resumé* of the work of the year. The address was listened to with great attention, and concluded amidst great applause.

A vote of thanks to the President for his valuable address was then moved by Mr. J. G. Waller, seconded by Mr. Ingpen, and carried unanimously.

The President, in acknowledging the vote of thanks, expressed his regret that he had been prevented by want of time from giving more attention to the preparation of his address; he had only returned from Scotland a few days since, which was the reason why it had been somewhat shorter than usual.

Mr. Golding moved that the address of the President be printed and circulated in the usual way amongst the members of the Club.

Mr. White seconded the motion, which was put and carried *nem. dis.*

Mr. T. Curties proposed a vote of thanks to the Committee and Officers of the Club for their management of its affairs during the past year, and the proposal having been seconded and put to the meeting, was unanimously carried.

Mr. J. E. Ingpen said it might be supposed that the last vote of thanks had included the one which he was about to propose; he thought, however, that he should be quite expressing the general feeling of the members in proposing a special vote of thanks to their retiring honorary secretary. As they had done him the honour to elect him as Mr. White's successor, he was perhaps in a better position than most of them to make this proposal. He was sure from what he could already see that Mr. White had held no sinecure (and for his own part he felt very glad to find that some assistance was in future to be given). The work to be done was very considerable, and it did not all lie upon the surface; in addition to other duties a great deal was often required in matters of tact and conciliation, which generally contributed towards making the machinery of the Club run smoother, as well as preventing collisions which might now and then occur with detrimental effect. They had also seen a great deal of Mr. White in other ways; they had ever the benefit of his scientific experience, ever his ready help, and ever his geniality and kindness. He (Mr. Ingpen) was very glad to find that Mr. White had been elected as a member of their Committee, so that they should still have the benefit of his counsel, and in one respect he thought that the Club would be a gainer, because they now had the promise of some papers from him upon Animal Histology, which would be very interesting as supplementing those which were now in course of being read by Dr. Braithwaite. He had great pleasure in proposing that a cordial vote of thanks be presented to Mr. T. C. White for his great exertions for the welfare of the Club during the four years he had acted as their Honorary Secretary.

Mr. W. H. Golding having seconded the motion, it was put to the meeting by the President, and carried unanimously amidst great applause.

The President, addressing Mr. T. C. White, said he had a further and still more pleasant duty to perform, that of presenting him with a testimonial from a number of the members of the Club upon the occasion of his retirement from the office of hon. secretary. The testimonial was in the form of a diamond ring (which he believed had been the form chosen by Mr. White himself), and he had great pleasure in presenting it on behalf of the members as a token of their sense of the value of his services as their hon. secretary.

Mr. T. C. White (who rose amidst great cheering) said that he felt most gratified by the kindness and cordiality of the way in which the members present had accorded their thanks to him on that occasion; indeed, he could hardly say that it had taken him by surprise, because he had received from them at all times so very much kindness and so many undoubted expressions of their good-will. He regretted very much that it had become a necessity for him to give up his position as their secretary, but the great increase of his professional engagements, which frequently occupied him from nine o'clock in the morning until six o'clock in the evening without any intermission, added to his other work, had begun to tell seriously upon his health, and for months past had resulted in almost constant headache, so that he felt compelled to give up his position in order to obtain some really needful rest. The regret with which he left that chair was, however, softened by a knowledge of the ability of the gentleman who was to be his successor, and by the assurance that he was in every way as fond of the club. He thanked them very much indeed for their handsome

present ; he should never look at it without thinking of their kindness, and how many times he had shaken hands with those who at their meetings had always given him such a cordial welcome and support during the period he had the honour to be their Secretary.

Mr. White then vacated the Secretary's chair, which was at once occupied by the newly-elected Hon. Secretary—Mr. John E. Ingpen.

A vote of thanks to the Scrutineers was moved by Mr. B. D. Jackson, and having been seconded and put to the meeting was carried unanimously.

The Secretary announced the following donations to the Club since the last meeting:—

"The Monthly Microscopical Journal"	from the Publisher.
"The Popular Science Review"	,, ,,
"Science Gossip"	,, ,,
"Proceedings of the Royal Society, No. 145." ...	the Society.
"The 4th Annual Report of the Liverpool Natural History Society"	the Society.
"The Proceedings of the British Natural History Society"	the Society.
"The American Naturalist"	in exchange.
"The Journal of the London Institution"	from the Librarian.
1 Slide	Mr. Alfd. Allen.
6 Slides	Mr. Jas. Watkins.

The thanks of the Club were voted to the Donors.

The following gentlemen were ballotted for, and duly elected members of the Club:—Mr. John Baguley, Rev. H. J. Fase, Mr. John Thos. Hurst, Mr. C. Le Pelley, Mr. John S. Walker, and Mr. Walter White.

Mr. Thos. Crook hoped he should not be out of place in saying a few words then, but he thought that there was one gentleman to whom a vote of thanks should be certainly given, and that was to Mr. Lewis, their shorthand writer; he, therefore, wished to propose that the thanks of the Club be given to Mr. Lewis for his services.

The motion having been seconded,

Mr. T. C. White said that if it were necessary to "third it" he would do so, because he felt so strongly the value of Mr. Lewis's work; indeed he did not know what they would do without it. He had intended to move this proposal himself, but Mr. Crook had quite taken the wind out of his sails.

The President thought after the manner in which the proposal for this vote of thanks had been received, it was scarcely necessary to put it to the meeting. It was then put, and carried unanimously.

Mr. T. C. White then proposed votes of thanks to the Librarian and the Curator, also to their Treasurer, Mr. Hardwicke, which, having been seconded, were put to the meeting, and carried unanimously.

The proceedings then terminated with a conversazione, at which the following objects were exhibited:—

Lophopus crystallinus	by Mr. Cocks.
Starch Grains in leaf cells of Moss *Mnium cuspidatum* ...	,, Mr. Sigsworth.
Scales of Lepisma (new species)	,, Mr. Ward.

Attendance: members, 70; visitors, 2.

22nd August, 1873.—Dr. Braithwaite *in the Chair.*

The minutes of the preceding meeting were read and confirmed.

The following donations to the Club were announced, viz. :—

"Science Gossip" } for August from the Publisher.
"Monthly Microscopical Journal" }
"Proceedings of the Geological Association" ,, Association.

The ballot for new members then took place, and the following gentlemen were duly elected members of the Club:—Mr. William Bartlett, Cambridge Villa, Southall; Mr. S. Israel, No. 1, The Crescent, America Square.

The President announced that there was no paper for this evening, but that Mr. Lowne had kindly volunteered to make a few observations on "The Mouth Organs of Insects."

Mr. Lowne said that previous to his coming into the room he had no idea that he would be asked to fill up the gap caused by the want of a regular paper, and that it was only fair he should make that statement, as entitling him to the consideration of the meeting for the unprepared condition in which he addressed them. He proposed to offer a few observations respecting the Mouths of Insects, which, as we all knew, were favourite objects, considerable portions of our cabinets being filled with them, and although the subject was not a very novel one, yet he hoped that he might be able to put it more fully before the members than was commonly done in works of an elementary nature, and more clearly than in those of a more portentous character.

If we take the mouth of any large beetle, we find all the parts easy to recognise, with the additional advantage that all the structures are the same relatively as in the most modified mouths, even of those modified for special purposes. The use, in other words, may be different, but the parts are the same, though not always easy to recognise as such. There is nothing, for instance, in a fly's mouth, which does not exist, in a plainer condition, in the mouth of a beetle. If we take a Stag-beetle, we observe first the large horns, which are the mandibles or jaws of the insect. We observe next that these work laterally, not vertically, as in the case of mammalia, &c., and this is the case with all insects. Above the mouth we find a plate, forming the roof of the mouth, and underneath another plate forming the floor of the mouth; both of these lie parallel with each other. The mandibles, like those of all other insects, are hollow, and are moved by very powerful muscles. Whether they are in this case used for procuring food, or are simply ornaments, the speaker could not undertake to say. In the instance of the Stag-beetle, the mandibles are comparatively feeble in proportion to the size of the insect, but in others they were frequently of great strength. In a little space, under these mandibles, there are two jaws, which also move parallel to the roof and floor of the mouth; these are the *maxillæ*, which are sometimes cutting organs, and occasionally more developed than the mandibles. We now see that, as far as we have gone, the main parts of the mouth are—

The upper lip, or *labrum*.
The lower lip, or *labium*.
The mandibles.
The maxillæ.

If we now take a magnifying glass, we find another organ called the *ligula* or tongue, springing from the floor of the mouth, the same as in the higher animals. This organ is much modified in different insects, as for instance in bees, which have about 300 joints. The general use of the tongue of a bee is

to lap up the nectar from flowers, much in the same way as a kitten laps up milk. This is the highest development of the *ligula*, or tongue, which is known in the insect world.

In many flies the tongue is without muscles; it is very pointed, and is used as a lancet. You will call to mind, as a different modification of this organ, the tongue of the cricket. The tongue of the blow-fly, so called, is not simply a tongue, but a modification of the whole of the mouth organs; that of the cricket, on the other hand, is really a tongue.

On either side of the *ligula* there are two small organs—jaws, which in the beetle serve no object at all; they are simply jaws on their last legs. All the jaws of insects are legs. Take them in an embryonic condition, and you will find that the jaw and the leg pouches are identical in form, and it is only when developed that the difference is apparent. These little jaws are the *paraglossæ*.

In the grasshopper, cricket, and dragon-fly, the two pairs of maxillæ lie one below the other. They attain their greatest development in the dragon-fly, and even hide the mouth of the insect, and in the larva of the dragon-fly they are of such dimensions as to cover the ugly head, and enable it to approach near its prey.

Attached to the two pairs of *maxillæ* of crickets, and to the *paraglossæ* of beetles, we find small jointed organs called *palpi*. These contain a very curious structure, of an extremely delicate nature, in which the nerve is probably brought almost in contact with the insects' food. Those attached to the *paraglossæ* are called labial palpi, and those which are joined on to the *maxillæ* are called maxillary palpi.

We now come to the modification of these organs.

In the bee the parts are all the same as in the beetle, except that the *paraglossæ*, tongue, and *palpi* are very much modified. The tongue is much lengthened, like an elephant's tongue in miniature, owing to its highly complicated muscular structure. On either side are the labial *palpi*, which contain no more joints than in the beetles, but these are enormously drawn out. Whether these are tasting organs, we cannot say, but it is highly probable that this is their use. Between them the tongue works up and down into the nectary of the flower with a very, a marvellously rapid motion, and being covered with fine hairs, it thus brings up the nectar. To aid in this, the tongue terminates in a leaf-like appendage. Not only are the labial palpi developed into a sheath for the tongue, but the *maxillæ* form a covering to the back of the tongue. The maxillary palpi are developed into a knife-like organ, which is used to plaster the wax, or cut leaves, according to the habits of the particular bee. They are very sensitive, exceedingly complicated, and are the building organs of the insect, modified to the use of the different species. For instance, in the upholsterer bee they are curved and scythe-like, and in the rose-cutter bee, they form saws, the teeth of which are set at an angle of 45° to each other.

In the mouth of the blow-fly we notice the great development of the lower lip or *mentum*. The tongue is very small, but the *mentum* is much developed. The lobes are the *paraglossæ* in a highly developed condition. If the *mentum* is opened out as in Mr. Topping's well known slide, we find the same parts as in the beetle, but in a much more developed state. On the upper side is a groove which forms the floor of the mouth. In this mouth the organs are, fortunately for us (considering how common an insect the blow fly is), only very rudimentary. There are plenty of flies *like* the blow-fly, which unlike him, can open their mouths and can push in a bundle of six lancets to the skin; they

then cut their way out by diverging, then retract, and finally suck in the same way as the blow-fly does.

The so-called false tracheæ are the channels through which the blow-fly feeds, and act as filters to his food. They can be closed up at pleasure of the insect by some 40 or 50 teeth, so that no solid food can pass. In the gullet is a suction and force pump, a wonderful organ of great power, and thus we see the need of a filtering organ, without which the fly would choke; not in the sense that one of the higher animals would choke, inasmuch as insects do not breathe by the mouth but by the apparatus provided by the spiracles and tracheæ, but by reason of its being unable to feed.

In butterflies and moths the structure is again much modified. The tube of the mouth is formed by the lateral organs, probably by the *maxillæ*, and is a hollow, jointed, and muscular organ, like that of the bee. So far as we know no butterfly or moth has a true tongue. In them the tube opens below, and goes right up to the mouth. They have only 2 *palpi*—no other mouth organs, and their use is to clean the proboscis, to which they form fleshy cushions. The tongue, when not in use, is rolled up into a spiral, but when in action, all the muscles straighten out, and form a tube for suction. The locality of the suctorial power has not yet been determined, but probably the mouth cell acts as a kind of pump.

Time will not allow of more being said as to their uses to other creatures. These are in many cases no doubt purely accidental, or it may be that plants have been modified, many of which are incapable of producing seed, unless visited by moths. There are a remarkable number of plants which are fertilised by nocturnal moths. The tongue of the bee is no doubt adapted and essential to the fertilisation of many, still we can well see that the lapping action of the bee is not so well adapted to this end as the delicate poising of the tongue of the moth. Time, however, forbids our going further into the consideration of this matter, and in conclusion the speaker thanked the members for the attention with which they had favoured him.*

Dr. Braithwaite proposed a hearty vote of thanks to Mr. Lowne, and said that so interesting a communication would, he was sure, prevent the members present from feeling any regret at there being no paper for the evening.

The vote of thanks was then put, and carried unanimously.

A spirited discussion then followed, in the course of which

Mr. McIntire asked the use of the various appendages to the *antlia*, which in some moths were entirely wanting.

Mr. Lowne replied that it was quite possible that they were tasting organs, as it is clear that from the nature of its food the moth cannot taste with its palpi.

In reply to personal thanks, and to questions put by Mr. James Smith,

Mr. Lowne stated that he had omitted to say that with regard to the organs at the extremity of the proboscis, there was in *Nature*, six weeks ago by H. Müller, an article on fertilisation of plants by insects, illustrated by drawings of the various organs. He would not say that the organs referred to were organs of taste, but as regarded their structure simply, they were undoubtedly modified scales.

After some further remarks by Mr. McIntire and Mr. Ingpen, with reference to modification in particular cases,

Mr. Loy asked whether Mr. Lowne did not agree that the mandibles of the Stag-beetle were used to obtain juice from the plants upon which they feed.

* Mr. Lowne illustrated his remarks by bold, yet accurate, sketches on the black board.

He (Mr. Loy) had often seen them feeding on the sap so obtained. With regard to the statement that the jaws of the Stag-beetle had not much power, Mr. Loy considered that they were on the contrary very strong, as he had experienced when bitten by them; they would also hold a stick very tightly. As far as he had observed their feeding time was about eleven to twelve o'clock at night.

Mr. Lowne was glad to hear that the Stag-beetle could bite, and equally glad that he had not experienced the fact in his own person.

Mr. Loy remarked on the muscular irritability in these insects; a pair of the mandibles removed from the head retained the power of motion for some hours.

Mr. Lowne could well believe this. It was well known that the legs of some *Phalangidæ* would move as long as twelve hours after separation from the body.

Mr. J. E. Ingpen then made a communication relative to a portable microscope which he had brought down for the inspection of members, and which he thought superior to the small instruments generally employed on holiday excursions, inasmuch as an instrument is often useful on such occasions capable of *examining*, in contradistinction to merely *recognising* objects. The microscope, which was originally a Smith and Beck's instrument, had been very ingeniously modified to suit these requirements, whilst great attention had evidently been given to lightness and economy of space. In a small case were contained three powers, viz., 2-in., $\frac{2}{3}$-in., and $\frac{1}{4}$-in., three eye pieces, and a Kelner eye piece, the latter being employed also as an achromatic condenser, a small bullseye condenser, live box, compressorium, polariscope, camera lucida, spot lens, micrometer, spare slides, forceps, &c. Nothing new was claimed except in the adaptation of the instrument to seaside work, and the arrangement by which a complete apparatus was comprised in a very small space.

Thanks were voted to Mr. Ingpen, and carried unanimously.

Notices of the next excursion and the gossip meeting for September were then given, and the meeting closed with the usual conversazione.

The following objects were exhibited:—

Section of Eye of Drone-fly	Mr. A. Topping.
Spiracles of *Dytiscus marginalis* polarised	Mr. Sigsworth.
Wing of *Vanessa Io*	Mr. G. Williams.
Collection of *Diatomaceæ*, made by Mr. F. Kitton, of Norwich	Mr. H. F. Hailes.

12th September, 1873.—Conversational Meeting.

The following objects were exhibited:—

Crystals of Silicate of Potash in Cobalt glass—dark ground	Mr. Sigsworth.
Palate of *Helix lapicida*	Mr. J. Slade.
Endothelium on diaphragm of Rabbit	Mr. Ward.
Tongue of a West Indian Spider	Mr. McIntire.
Echinus Spines ... ... Spicula of *Synapta*	Mr. Golding.
Pollen of *Passiflora*	Mr. Martinelli.
Fungus on Tea Leaf ... ... Marine Organism (unknown)	Mr. Pett.
Terpsinöe musica	Mr. J. E. Ingpen.
Swift's New $\frac{1}{6}$th Objective	Mr. Geo. Williams.

On the Histology of Plants.

By R. Braithwaite, M.D., F.L.S.

III. Transformation of Cells.

(Read Nov. 28th, 1873.)

We pass now from individual cells, and proceed to study the changes produced in them by growth, and by combination into tissues. In the young state, nutrition is active, and the elements of the plasma contained in the cells are capable of rapid assimilation, consequently we have an increase in the whole volume of the cell, both the primordial membrane and cellulose case participating, and then commences an internal deposit of cellulose, by which the cellulose case becomes thickened to a greater or less extent. This increase in volume we may assume takes place in three directions —vertically, antero-posteriorly, and laterally—so that a change in form is soon set up in the growing cell, and this in two ways; firstly, nutrition may not proceed uniformly in all parts of the cell, and thus extension takes place in certain directions, and not at all in others; secondly, the rapidly enlarging cells soon begin to press against each other, and thus become moulded into various shapes. So long as the cells remain free, and nutrition progresses equally on all sides, they retain their spherical form, as we may observe in the spores of Algæ and mosses, in pollen, and in the soft pulp of fruits; but if they combine into a tissue, their spheroidal shape is changed by mutual pressure, and they acquire a more or less polyhedral form, as we may observe in the albumen of seeds, and in pith cells, or in the potato.

If nutrition proceeds in all three directions, but not equally over the whole surface, we have radiate forms, as in stellate hairs, or if it be still more irregular we get branched cells, such as we see in the hairs in the air passages of *Nymphæa* or in the bast-tissue of Conifers; if nutrition proceeds only in two directions, and is arrested

in the third, we get the tabular cells, roundish, polygonal, or stellate, so well seen in the cuticle of leaves, and in the partitions of the air passages in rushes or in *Alisma Plantago*; in cork-tissue they are nearly rectangular, hexagonal in the leaves of Hepaticæ, and beautifully radiate in many Desmids, such as *Euastrum Micrasterias*, &c. If growth goes on in only one of the cell diameters, we get long cylinders, as in the whole group of filiform Algæ, in the pallisade parenchyma of leaves, and vessels of higher plants; or prisms in vessels and wood and bast parenchyma; or filiform in many hairs, of which cotton is a familiar example. Irregular extension produces branching of the elongate cells, as seen in the bast cells of Asclepiads and in the Cinenchyma or laticiferous vessels carrying the milky sap of composite and papaveraceous plants, which ramify and anastomose repeatedly.

Following immediately on extension of the cell is a thickening of the cellulose case, which may take place equally on all sides, as in pith and wood cells, or may be more or less confined to one side of the cell. The amount of deposit may be so slight as to be scarcely noticeable, or in the case of wood and bast cells, it may fill up and almost obliterate the entire lumen or central cavity of the cell. The thickening of the cellulose case on one side is best seen in cells of the epidermis, where it may occupy the whole of the wall on one side, or also parts of the two adjacent walls, as is seen in the cuticle of Mistletoe, or of Allium, Hyacinth, &c. A partial thickening in the angles is seen in Hepaticæ, and in the collenchyma of young cabbage stems.

Lamination of the Cellulose.—As a rule, the different parts of the cellulose case, originating at different periods, and increased by deposit of cellulose particles separated from the protoplasm, and placed uniformly over the primordial membrane, differ also in their optical character, and for this reason we may distinguish three coats. 1. The primary, which is thickest; 2. The secondary deposit in laminæ, or systems of laminæ; and 3. The tertiary, youngest and most internal. Sulphuric acid or caustic soda will bring out the laminæ of the secondary deposit when not evident, and an interesting question arises, How is this lamellation caused? Nägeli says in the same way as in starch granules; by the differentiation of an originally homogeneous deposit into layers containing different amounts of water, but the older view is, that in the process of deposit certain periodical stops take place, each

of these arrests causing an empty interspace, which is indicated by a dark line, and that this is very likely to be correct is proved by placing extremely thin sections of the pith of *Clematis*, or of bast cells of *Begonia* in canada balsam, which has the same refraction as cellulose, and will, on filling the interspaces, cause the black lines to disappear, while in anise oil, which is more highly refracting, the phenomena are reversed, the dark striæ being now the brightest. To study the origin of the layers in unilateral secondary deposit, the epidermis cells in young leaf buds of mistletoe, and the outer wood cells in shoots and radicles of Conifers are adapted; for concentric lamination we select bast and pith cells, or the stem of *Clematis Vitalba.*

Forms of Secondary Deposit.—The layers of concentric deposition are never complete, but portions of the primary cellulose case, of greater or less extent, are free from the thickening. The forms in which thickening occurs are many, but the principal may be classed as *annular*, *spiral*, *net-like*, *porose* and *cribrose.*

1. *Annular thickening* of the cellulose membrane is seen occasionally in parenchymatous and filiform cells, and in none more beautifully than in the hyaline cells of a Sphagnum leaf; we have also good examples in the parenchyma of Cactaceæ, where the thick rings extend inward like a plate. The rings vary in their distance from each other, and also in their inclination to the axis of the cell, and we may notice in *Tradescantia*, *Balsamina*, &c., a gradual transition into the next form.

2. *Spiral thickening* is often in form of homogeneous thickening on one side of the cell; it is well seen in the elaters of Hepaticæ, in Sphagnum leaves, and in the epidermis of anthers in Cucurbitaceæ and Liliaceæ, in the seed coat of *Salvia*, *Taraxacum*, *Polemonium*, &c., and in the vessels of Hyacinth, Arum, &c. Their direction is usually to the left, but sometimes we find them turn to the right and left in the same cell, as in the wall of the anthers of pumpkin. The spiral band is constructed precisely as the thickening layer of the whole cell, having a primary layer next the lining of the cell, an internal tertiary and middle secondary layer, and these may be best seen in the large bands of the Balsam. In the bast cells of Apocynaceæ and Urticeæ, of the larch, and in the outer part of the annual ring of Conifers, the spiral thickening layers are deposited in bands, with numerous unthickened striæ between, and these were mistaken by Agardh and Meyen for a

striation of the cell wall. In *Vinca* and some other Apocyneæ both left and right-handed complex spirals occur.

3. *Reticular thickening layers* are common in parenchymatous cells of the leaves in Liliaceæ, in capsules of Hepaticæ, in the collenchyma of elder, and in the bark tissue of Balsam.

4. *Porose thickening layers* are seen in most cells of the higher plants, the pores appearing as small flat rings where the secondary deposit is very thin, but as a cylindric canal when this layer is thick. We have closed and open pores, though originally all are closed; but where pores of adjoining cells correspond, absorption of the intervening cellulose case converts them into a canal, by which air passes into the interior. Closed pores are especially seen in the parenchyma, or in all cells destined to prepare and store up reserve material. The pore canal is usually cylindric, but sometimes it is narrowed externally, and in very strongly thickened parenchymatous cells the pore canals are often branched, as we see in the thickened woody parenchymatous cells forming the hard concretions in winter pears, in the shells of stone-fruits, in the albumen of the ivory-nut, and in the bark of Ash, Fir, Hoya, &c. Closed pores may be also somewhat widened at base, so that the real aperture appears bordered by a second circle. Similar bordered open pores are found in all cells, which having finished their thickening layers only carry air; these are seen in most wood cells, in all bast cells, and also in all vascular cells of woody tissues. In bast cells we often find that the aperture of the canal becomes so small that the border is indistinct.

In the vascular cells the bordered open pores appear externally on the lateral walls, and also on the transverse ones, and thus free communication is established throughout, as we see in Ash, Maple, &c.

If the border as well as the pore canal be extended considerably in width, we have the form known as *Scalariform*, or ladder-like, so very common in the vascular cells of Ferns, Lycopods and Monocotyledons, and also in the partition walls of the pith in Conifers. Combined porose and spiral thickening occurs in some wood cells as in those of Yew, *Viburnum Lantana*, &c., and in vascular cells of Maple, Lime, and Honeysuckle, the spiral band being a tertiary layer. Other peculiar forms are seen by transverse section, in the parenchyma of the leaf of *Cycas revoluta* as semicylindric bands, and of *Pinus sylvestris*, where they project like

little pin's heads into the cell lumen; these are produced like the pores of wood cells by a fold of the young cellulose case. In petals, and especially well seen in the papilliform epidermal cells on those of the Pelargonium, we have both folding of the primary cellulose case, and also secondary deposit. In the epidermis cells of the leaves of many Urticaceæ, the thickening is limited to one point, but this grows remarkably, forming spheroidal cellulose bodies, termed *cystoliths*, which are encrusted with calcareous crystals; good examples of these will be found in a leaf of *Ficus elastica*, or Indiarubber plant, where they are seen on section to occupy a large crypt, from the roof of which they hang by a slender pedicel, and a distinct nucleus is visible in their interior; the leaves of *Broussonetia* and *Morus* also afford specimens.

Origin of the various Forms of Thickening.—You will remember when speaking of the young cell, that I alluded to the currents of protoplasm traversing the cell walls in various directions, as streams of granules; in these we have the foundation of the patterns assumed by secondary deposit, and the source from which it is derived. The elater cells in the young fruit of Marchantia have been watched to trace the process, and the first thing seen is a parietal border of protoplasm, enclosing starch granules, next vacuoles appear, and then the granular protoplasm commences a distinctly spiral movement, the starch disappears, and a homogeneous layer of cellulose is seen clinging spirally to the cellulose case.

Bordered open pores are best seen in young shoots of Conifers, and commence by an infolding of the primordial utricle, then the bordering cavity enlarges, and the pore canal becomes narrowed by internal deposit. In most parenchym cells, Iodine shows us that the cellulose remains unaltered, but in other cases a change takes place; thus wood, bast, and vascular cells, and many unilaterally thickened epidermis cells, lose their original soft condition, and become hard; Iodine tests now colour them yellow, and they are dissolved in warm caustic potass, and also by nitric acid, the cellulose has been converted into *Lignin;* again, cells of the Periderm and of cork tissue present the same reaction, but are not dissolved by nitric acid, and moreover, they contain nitrogen. Here the cellulose is changed into *Suberin.*

Lignification commences at the exterior, but never entirely

changes the whole cellulose; the primary is most changed, but the tertiary is often not altered.

Suberification appears only in the layers of the plant-tissue exposed to atmospheric influence. In the epidermis it occurs mostly in the outermost cuticular layers, lying under the true cuticle; but here also the whole cellulose is not transformed. The young cork cells also, after treatment with caustic potass, give an indication of cellulose, but in the older layers it entirely disappears.

Intercellular Substance and Cuticle.—These may be mentioned here, as they seem to be identical in constitution, and both altered conditions of cellulose. They may be regarded as the first coat separated from the primordial membrane, within which the true cellulose layers are deposited.

Illustrative Figures.

Plate 8.

1.—Stellate cell from wall of air passages in *Butomus umbellatus.* × 360.

2.—Milk vessel from *Carica microcarpa.* × 400.

3.—Unilaterally thickened cells from cuticle of a branch of Mistletoe. × 660. *c.* cuticle; *p.* primary; *s.* secondary; *t.* tertiary layers.

4.—Cell thickened in the angles from leaf of a *Jungermania.* × 660.

5.—Section of a concentrically thickened bast cell from Larch, showing three pore canals. × 780.

6.—Section of a wood cell of Beech, the secondary deposit not laminated. × 780.

7.—Ringed cell from capsule wall of *Pellia epiphylla.* × 400.

8.—Cell with double spiral band from anther-wall of Pumpkin. × 400.

9.—Striation of the cellulose case. Fragment of an abnormally thickened wood-cell from inner part of the annual ring of a branch of *Pinus silvestris*, with spiral bands of inner, secondary, and tertiary layers. At *x* only the lower wall of the cut cell is seen. × 900.

10.—Parenchym cell from partition of Walnut. × 660.

11.—Albumen cells of Ivory nut, with pore canals. *P.* × 370.

12.—Bordered open pores of wood of *Pinus silvestris*. *A.* in section; *B.* seen on the surface; *P.* pore canal; *B.* border; *i.* intercellular substance. × 660.

13.—Cell from a transverse section of a leaf of *Pinus silvestris*, with knob-like thickening of the cellulose case. × 370.

14.—Thickened epidermis cells from petal of Pelargonium. *A.* seen from above; *B.* in vertical section. × 370.

PROCEEDINGS.

September 26th, 1873.—*Chairman*, Dr. R. Braithwaite, F.L.S., President.

The minutes of the preceding meeting were read and confirmed.

The following donations to the Club were announced :—

"The Monthly Microsopical Journal"	from the Publisher.
"Science Gossip"	,,
"The Proceedings of the Royal Society," No. 146	,, the Society.
"The American Naturalist" for July, August, and September	in exchange.
Four Slides of Lines Ruled on Glass	Mr. Wm. Webb.
£5 for the purchase of Books for the Library ...	Mr. F. Crisp.

Votes of thanks were unanimously passed to the donors.

Mr. William Parker was balloted for, and duly elected a Member of the Club.

Mr. M. C. Cooke read a paper upon collecting and preserving fresh-water algæ, which, at the request of the Committee, he had extracted from a work by Dr. Horatio Wood, jun., "On the Fresh Water Algæ of the United States," recently published by the Smithsonian Institution.*

The President, in proposing a vote of thanks to Mr. Cooke for the communication, reminded the Members of the Club that there was no greater field for microscopical research than that afforded by the fresh water algæ, and that few would prove more interesting to a worker. He recommended Rabenhorst's as being the best book on the subject. Amongst the many workers who were to be found in and around London, he thought much might be done, for no richer field existed in which to collect algæ, than the London district. The best way, he thought, would be for those who took up the subject to work in partnership—say a worker and a mounter, to carry on the study together. The mounting was a matter of much importance, and it was very desirable to find some means by which specimens could be permanently preserved. He believed that Jenner's collection was spoiled, or nearly so.

Mr. T. C. White said he had but little experience in mounting this class of objects, but he had found some keep very well, which he had put up simply in the water in which he had found them. Great attention must always be paid to the density of the medium employed, so that it might as nearly as possible resemble that of the water in which the objects were found, because if the density were increased the endochrome would become displaced and the objects destroyed. He had never tried carbolized water, but thought it might be useful, provided the specific gravity was the same as that of the original fluid. If,

* Printed at page 192, *ante*.

instead of breathing upon the under side of the glass cover before putting it over the cell, a drop of fluid were placed upon the middle of the cover, it would be found much more effectual in preventing air bubbles from being inclosed. Breathing was not always effectual, the moisture obtained in that way being very evanescent; but if a drop of the preservative fluid were placed on the under side of the cover so as to hang down from it, when the cover was placed on the cell the drop would join with the fluid inside, and spreading over the cover from the centre to the edge, would be found effectually to drive out the air. He should like to know how Dr. Wood could keep the cement from running in.

Dr. Matthews was quite sure that in mounting objects of this kind attention to the specific gravity of the fluid used was all important. The advantage of carbolic acid over creosote was found to be great, for although creosote when once thoroughly dissolved apparently afforded a very clear solution, yet after a while it deposited a crust within the cell, which in many cases destroyed the value of the slide ; no such thing, however, occurred when carbolic acid was used. There were several modifications of different preserving fluids which could be specially adapted to the substances to be preserved, and those which had carbolic acid for a base were the best for algæ. A saturated solution of arsenic in water formed the basis of another preservative fluid, for dilution with glycerine or spirit ; and a third kind of basis was camphor water, which, if filtered and re-filtered through the same filtering medium would be obtained of much greater strength than usual. The greatest difficulty, however, in preserving algæ, was in accommodating the specific gravity of the fluid to that of the specimen. Another point requiring attention was the great difficulty of preventing the cement from running in. Quekett found this to be a matter requiring much consideration, and proposed to cut a groove or ring round the object, and to put the ring of cement beyond it. His own impression was that time alone would be found effectual to enable the cement thoroughly to dry, and how long a time could only be taught by experience. A mixture of gum dammar and gold size could be strongly recommended. If a little cement were put down the side of the cell, it would cause the cement to run down there if anywhere, rather than on the glass.

Mr. James Smith thought that it might be worth while to try the effect of immersing the objects in carbolised water before mounting them, so as to ascertain if they would keep, and if so they could then be mounted.

The President assured Mr. Smith that there was no doubt upon that point – they would keep for years – but it should be remembered that when these objects were obtained they were very dirty, and required cleaning.

Mr. Hainworth asked why the objects often became of a brownish tint when mounted in carbolic acid and water ?

Dr. Matthews said this was because too much acid was used.

Dr. Foulerton exhibited to the meeting a bottle containing water and a specimen of Cyclops alive, which he had found in the neighbourhood of the Rocky Mountains. The water was obtained by him on May 11th, at a place called Green Rivers, situated at an elevation of about 6000 feet above the level of the sea, and not very far from Salt Lake City. The whole country about there was very flat—although called part of the Rocky Mountains—and it formed part of the district known as the Alkali Plains. Every here and there along these plains there were pools of water, and it occurred to him that it might be interesting to know if any living thing existed in these waters, because it was most probable

that they were strongly impregnated with alkali. During a short stoppage at Green Rivers, he obtained from one of these pools some water containing a large quantity of some sort of crustacean, some specimens of which were nearly half an inch long. The next morning he found the upper part of the water was clear, and the lower part thick, and also that it contained enormous quantities of Cyclops, all very lively, and closely resembling the common species. He made sure that no air was admitted to the bottle, and therefore that no evaporation or decrease in the water took place, and he examined it constantly up to July 15th, when the Cyclops seemed as numerous as ever. After July 15th he was separated from his baggage for about a month, and during this interval the bottle was kept in darkness instead of being in the light as before. When he examined it again he could only find two specimens, and by the middle of September there was only one. This one he had brought with him to the meeting.

The thanks of the meeting were voted to Dr. Foulerton for his communication.

The Secretary read a letter* from Dr. J. J. Woodward, of the Army Medical Department, Washington, upon Nobert's Tests, with reference to the paper upon the subject read by Mr. Webb, at the March meeting of the Club, and printed at p. 155 of the July number of the Journal.

Mr. Webb made some remarks upon Dr. Woodward's letter, and promised to write a reply to it.

The President brought to the meeting a number of specimens of woods, all named, and with one exception, the Wellingtonia—all recent cuttings—to be placed at the disposal of those members who were engaged in making wood sections, and he hoped that whilst preparing specimens for themselves, they would also prepare a set for the cabinet of the Club.

The various engagements for the ensuing month having been announced, and the list of gentlemen proposed for membership read, the proceedings terminated with a conversazione, at which the following objects were exhibited :—

Various Marine objects ... ... by	Mr. Fitch.
Section of Tooth of Fossil Fish	Mr. W. Hainworth, jun.
Marchantia Polymorpha, and its fructification	Mr. Martinelli.
Transverse section of Tooth of Ox (shown under one of his Travelling Microscopes)	Mr. Moginie.
Lepidozia Reptans	Mr. J. C. Sigsworth.
Section of Spur Hoof of Ram	Mr. Topping.
Pleurosigma Angulatum (shown under one of Mr. Swift's new $\frac{1}{6}$ in. objectives) ...	Mr. Geo. Williams.

Attendance—Members, 73; Visitors, 9.

October 10th, 1873.—Conversational Meeting.

The following objects were exhibited :—

Voluntary Muscle (Human)	Mr. Bartlett.
Pollen of Everlasting Flower	,,
Fang of Spider, showing Poison Hole	Mr. Fitch.
Larva from abdomen of Earwig	,,
Lips of Fly	Mr. Goodinge.
Cyclosis in *Anacharis*	Mr. Martinelli.

* Printed at p. 198 *ante*.

Operculum of *Trochus*...	... ...	Dr. Matthews.
Hippuric Acid (Polar)...	... ...	,,
Section of Spindle Tree (Polar)	... ...	Mr. Pett.
Bloom of *Plumbago Europæa*	... ...	Mr. Reeve.
Crystalline lens of Cat	... ...	Mr. Topping.
Gizzard of Flea	... ...	Mr. T. C. White.
Sphæraphides from *Echino-cactus*	... ...	,,
Muscular Fibre of Kitten	... ...	,,
Micrasterias mounted in its native water	...	,,

Attendance—Members, 63; Visitors, 3.

OCTOBER 25TH, 1873.—*Chairman*, DR. R. BRAITHWAITE, F.L.S., President.

The minutes of the preceding meeting were read and confirmed.

The following donations to the Club were announced :—

"The Popular Science Review" ...	... from the Publisher.
"The Monthly Microscopical Journal" ...	,,
"Science Gossip"	,,
"Proceedings of the Literary and Philosophical Society of Manchester" ...	the Society.
"Proceedings of the Bristol Naturalists' Society"	,,
"The Tenth Report of the Belfast Naturalists' Field Club"	the Club.
"The Lens"	in exchange.

The thanks of the Club were awarded to the donors.

The Secretary called attention to a paper in the "Proceedings of the Literary and Philosophical Society of Manchester," recommending napthaline as a support for soft tissues when cutting sections. Its melting point was low, and it did not shrink in cooling; but he thought its scent very disagreeable.

Mr. T. W. Burr believed that when it was properly refined its scent was much better, and it was something like camphor in appearance.

The following gentlemen were balloted for, and duly elected members of the Club:—Mr. Thomas J. Baker, M.R.C.S., Major Frank Bolton, Mr. Horace Dashwood, Mr. John R. Davies, Mr. John M. Knight, and Mr. John R. Williams.

The Secretary read a paper by Mr. William Webb, in reply to the letter from Dr. J. J. Woodward, on Nobert's Tests, which was read at the preceding meeting of the Club. In this paper Mr. Webb adhered to his opinion as to the character of the higher bands, and the absence of true lines upon them. With regard to his expression "aërial polarised black lines of light," he endeavoured thereby to convey his belief that they were lines of light *in air*, not on the glass, and produced by a complication of refracted rays, the first refraction being in the body of the glass, and the other refractions being of the emergent rays from the parallel surface, and the opposite and unequal surfaces of the bevelled sides of the incisions. His former paper was directed to the impossibility of ruling bands to the $\frac{1}{200000}$ of an inch, and he should be agreeably surprised if Dr. Woodward succeeded in resolving them. One of the objects of his paper was to bring out a discussion on the subject.

A few remarks were made by Mr. Burr and Mr. Ingpen upon Mr. Webb's paper, but they were merely of a technical character.

Mr. T. C. White presented a beautifully mounted slide of *Sphæraphides* of *Echino-cactus*, and stated that they were easily obtained by rubbing two pieces of the dry stem together, when the raphides fell out in great numbers, mixed with woody fibre. When cleaned and mounted in balsam they polarized beautifully, but he thought they looked best as opaque objects.

The thanks of the Club were voted to Mr. White for his donation.

Mr. Ingpen made some observations upon the construction and use of the Achromatic Prism. Quoting Quekett's treatise on the Microscope, he stated that the concave mirror was first used by Culpepper in 1750, and seemed to have sufficed for all purposes till in 1840 Dujardin employed the right-angled prism with flat sides in conjunction with his "eclairage" or achromatic condenser. Sir David Brewster had recommended a hemispherical lens, using the flat side as a reflector, but this did not appear to have been much employed. Amici's prism consisted, in effect, of two plano-convex lenses with a prism between them to change the direction of the pencil of rays. This was not achromatic, but Mr. Abrahams constructed a right-angled prism of flint glass, having one of its small faces hollowed out to receive a double convex lens of crown glass, which was cemented to it with Canada balsam, and thus rendered it achromatic. This was the form employed by Messrs. Powell and Lealand for their small prisms for oblique light. In another form, which was shewn to the meeting, a plano-concave lens of flint glass was cemented to one of the convex sides of an Amici prism, and this was probably somewhat superior to the other. This prism was mounted and used exactly like the mirror—the focus for parallel rays was 3½ inches from the side nearest the object, and the light was very pure; more so, he thought, than that of the mirror, and Mr. Quekett seemed to have held the same opinion. By altering the position of the prism it could be used for very oblique light, or to transmit parallel rays for the spot lens or paraboloid. He considered that the achromatic prism was hardly as well known, or as much used as it deserved to be.

The thanks of the Club were voted to Mr. Ingpen.

The President announced that the South London Microscopical and Natural History Club intended to hold a Soirée on or about November 20, at the Crystal Palace, and invited the co-operation of members of the Quekett Club on that occasion.

Mr. T. C. White asked for information respecting two slides of *Cynips* which he exhibited. Some time ago he gathered some oak galls, and having put them into a bottle, waited for the insects to hatch out. Owing perhaps to the mildness of the temperature some of them had done so. He dissected one of them with the idea of obtaining the rectal papillæ, but instead of doing so he got out another very extraordinary affair instead. He took after this a gall which, he thought, was rotten, but which, on opening, he found to contain an insect, and on dissecting it he found what he thought were ovisacs, but Mr. Lowne, who had seen them, was of opinion they were not. Mr. White then drew upon the board some sketches of the objects to which he had alluded, and gave some further particulars respecting them, concluding with a wish that Mr. Lowne would state his opinion as to what they were to the meeting.

Mr. Lowne said that he did not know whether he should be justified in saying much about these bodies, having only had a cursory glance at them; he thought, however, that he might be able to throw a little light upon the

matter, although the whole subject was very complex, and there was much about it concerning which they were still entirely in the dark. Mr. White's specimen had greatly surprised him, although the condition of things which he saw there was one common in worms. In all eggs there were two distinct parts—there was a germ forming the embryo, and the food on which the embryo was nourished. In the hen's egg, for instance, the large yellow yolk was the food yolk, and the little white speck was the germ; in the process of development all the rest was absorbed into, or eaten by the germ, the embryo grew at the expense of the food yolk, and was, in fact, nourished by it. In a large number of insects and in the worms two glands were found, one of which formed the germs and the other the yolks, and the germs and yolks were discharged simultaneously, both tubes opening into a common oviduct. Mr. Lowne then proceeded to explain by means of drawings on the black board, how, after the germ granule had been passed, the yolk granules were passed down upon it, and how segmentation subsequently took place. After examining Mr. White's specimen he had little doubt but that the granules there shown were true vitaline spheres, and he was much surprised to be shown an ovarian tube in which alternate germ yolks and food yolks occurred, for he had very little doubt that such was the nature of the two sets of granules. He thought that if Mr. White would follow up the subject, and examine these flies in every stage of development, a very interesting paper for the Club must result.

The thanks of the Club were unanimously voted to Mr. White and Mr. Lowne for their very interesting communications.

Mr. T. Curties gave notice of his intention to move "That a Special General Meeting of the Club be held on November 28th, 1873, to confer with the Committee as to the future publication of the Journal," but, after some discussion, it was ruled that the motion would be out of order, and it was therefore withdrawn.

The announcements of meetings for the ensuing month, and other matters having been made, the proceedings terminated with a conversazione, at which the following objects were exhibited:—

Planaria	Mr. Cocks.
Gizzard of Cricket, on opal ground	Mr. Curties.
Plumularia pennatula	Mr. Golding.
Planaria	Mr. Hainworth.
Section of eye of Tiger beetle	Mr. McIntire.
Spirorbis Nautiloides (alive)	Mr. Martinelli.
Section of Rush...	Dr. Matthews.
Tail of Carp (Polar)	,,
Foraminifera from the Atlantic, 1680 fathoms ...	Mr. Moginie.
Foot of Frog (injected)	Mr. Topping.
Ovisacs of *Cynips*	Mr. T. C. White.

Attendance—Members, 63; Visitors, 4.

November 14th, 1873.—Conversational Meeting.

The following objects were exhibited :—

Geometrical pattern of scales, diatoms, and foraminifera	Mr. Curties.
Fungoid growth on leaf-miner	Mr. Fitch.
Tongue of earwig	,,
Leaf of *Hippophäe rhamnöides*	Mr. Glasspoole.
Gemmellaria loriculata	Mr. Golding.
Foraminifera from corals and sponges	Mr. Hailes.
Photographed Diffraction-grating—3,000 lines to the inch—showing interference lines...	Mr. Ingpen.
Hippuric Acid	Mr. Priest.
Leg of Brazilian Beetle	Mr. F. Reeve.
Eye of Blow-fly (opaque, with ¼ inch objective)	Mr. Jas. Smith.
Hairs from flower of *Durio*, from Borneo	Mr. J. A. Smith.
Section of leaf of *Ficus elastica*	Mr. T. C. White.
"Science Gossip" Section cutter	Mr. Walter White.
Cyclosis in *Anacharis*, with ⅛ inch objective	Mr. Geo. Williams.

Attendance—Members, 67; Visitors, 4.

Nov. 28th, 1873.—*Chairman*, Dr. R. Braithwaite, F.L.S., President.

The minutes of the preceding meeting were read and confirmed.

Mr. Charles Cradock Underwood was balloted for, and duly elected a member of the Club.

The following donations to the Club were announced :—

"The Monthly Microscopical Journal"... ..	from the Publisher.
"Science Gossip"	,,
"The American Naturalist" (Oct. and Nov.)...	in exchange.
"Proceedings of the Geologists' Association"...	from the Association.
"Proceedings of the Literary and Philosophical Society of Manchester"	the Association.
"The 3rd, 4th, 5th, and 6th Reports of the Colonial Museum and Laboratory of New Zealand, and a Catalogue of the Birds of New Zealand"	Mr. Thos. J. Barratt.
"The Geological Survey of Canada"	Mr. Kettle.
6 Slides	Mr. S. Israel.
4 Slides of Sections	Mr. Walter White.

The thanks of the Club were voted to the donors.

The chair having been taken *pro tem.* by Mr. Chas. F. White,

Dr. Braithwaite read a paper "On the changes in the cell during the process of growth."* The paper was in continuance of the series "On the Histology of Plants," and was illustrated by black board drawings.

* Printed at page 211.

The thanks of the meeting were unanimously voted to the President for his paper.

Mr. T. C. White said that of the many methods of investigation which had proved of value to the practical Histologist, none was more important than section cutting; without it, in fact, the structure of many organs could never be ascertained. Many kinds of apparatus had been devised for the purpose of cutting thin sections, but though very excellent in their way, they were for the most part too expensive to come within the reach of the amateur or student. He therefore introduced to their notice a simple contrivance which he had used with great success for some time, and which consisted of a brass tube inserted at right angles into a brass plate, upon which a plate of glass, with a corresponding aperture, was cemented, so as to give a smooth and true surface, upon which to pass the cutting instrument. The substance to be cut was imbedded in an inner tube, and was pressed up with the finger as required. He was aware that several gentlemen in the room had paid attention to the subject, and had met with great success, and he hoped that his reference to the matter would induce them to communicate the results of their own experience to the meeting.

In pursuance of the subject, the Secretary read a paper by Mr. Walter White on "The Science Gossip Section Cutting Machine," so called from its having been first described in a communication to that periodical, which appeared in August, 1873. One of the instruments was exhibited in the room, and its cost was stated to be not more than 7s. 6d. In this instrument the plug holding the section is propelled by slight blows upon a wedge, instead of the usual screw movement, and it was stated that the substance to be cut being raised by *percussion*, did not suffer from the effects of unequal pressure as was sometimes the case when a screw was employed.

The thanks of the Club were unanimously voted to Mr. Walter White for his communication.

The President said he was himself one of those persons who did not possess a machine for this purpose, but he was accustomed to make sections of sphagnum leaves by inserting them in a slip of soft cork and cutting them by hand. Sections of the India Rubber Plant *(Ficus Elastica)* and others could be cut in this way.

Mr. T. C. White said that as the President had mentioned *Ficus Elastica* he might say that he had cut some good specimens of it, one of which he had brought for exhibition.

The President said that he had himself unfortunately no time to devote to section cutting, but he hoped that those who had would not fail to mount a few sections for the cabinet

Mr. T. C. White expressed his willingness to contribute a specimen of *Ficus Elastica.*

The President having announced the conversational meeting for the ensuing month, and that there would be no meeting on December 26th, the names of gentlemen proposed for membership were read and ordered to be suspended, and the proceedings terminated with a conversazione, at which the following objects were exhibited.—

Young of Lobster... ... ... by Mr. Curties.
Section of Calcedony ... ... Mr. Dunning.
Scales of Dog Fish ... ... Mr. Glasspoole.
Spicules of *Synapta* ... ... Mr. Hainworth.
Pentagonal plates of *Echinus*... ... ... Mr. Martinelli.

Tongue of Blow Fly	Mr. Richards.
Pollen of *Hibiscus Africanus*	Mr. Watkins.
Daphnia Pulex, alive, with young already hatched in the body	Mr. Geo. Williams.

Attendance—Members, 79; Visitors, 7.

DECEMBER 12th, 1873.—CONVERSATIONAL MEETING.

The following objects were exhibited :—

Wings of Foreign Lepidoptera	Mr. Ward.
Scale of *Podura* (dark ground $\frac{1}{6}$ objective)	Mr. Dunning.
Human Fœtus, one month old...	Dr. Matthews.
Caligus. Sp. (?)	Mr. T. C. White.
Sclerogenous tissue of Pear	,, ,,

Attendance—Members, 43 ; Visitors, 3.

On a New Form of Deep Cell, made by the Tilghman Patent Sand Blast Process.

By Henry F. Hailes.

(Read January 23rd, 1874.)

I wish to call the attention of the Club to what I may term another solution of the great cell difficulty; it remains to be seen whether experience will justify me in calling it an improvement.

Those who have tried mounting in balsam with any of the ordinary cells must have found that it is by no means an easy task to perform satisfactorily.

The fact of there being two joints—one where the cell is attached to the slide, and the other where the cover is joined to the cell—is a great source of trouble, air bubbles being very apt to find their way in either at one or the other of the joints.

Perhaps the best forms of cell that have as yet been devised are those ground out of the slide itself; but these, as hitherto made, are open to several objections—they are either very shallow, or very large, or both—the object is very apt, either in the process of mounting or afterwards, to shift to one side or the other, and to get wedged in between the cover and the bottom of the cell.

It occurred to me that possibly the Patent Sand Blast process might be turned to account for this purpose, and having the advantage of knowing the inventor, General Tilghman, I got him to have a few slides sunk for me as an experiment, and these slides proving satisfactory, as far as I could judge, I made an arrangement with him to supply me with a quantity of them, with cells of various sizes and depths. The cells may by this process be sunk into the slide any required depth or shape, irrespective of the sizes, which may also be varied. I find a small, deep cell, about one-fifth of an inch in diameter, very useful for mounting Foraminifera. An object can be put under the centre of the slide, covered, and hardened off without any risk of shifting; and even if the balsam does not get quite hard in the cell, the object can never get out of its place.

Of course the Sand Blast process leaves the cell in a rough, or

unpolished state, but this is only an apparent disadvantage. The refractive index of the balsam is so nearly that of glass, that it causes the granulation entirely to disappear. For mounting in fluids of less density than balsam, it is necessary to run a little balsam into the cell, and dry it off before putting in the fluid. For dry or opaque objects, no preparation is necessary, the ground-glass bottom of the cell making a soft and agreeable background for the object.

For mounting insects, or parts of insects, either as opaque or transparent objects, I venture to think that the use of these cells will be found far preferable to the flattening process usually adopted, and which is less necessary now that we have such good binocular microscopes than it was formerly. I suppose there are no entomologists who would entertain the idea of putting a large insect, such as a stag beetle, through a rolling mill, in order to preserve it, and I can see no reason why a flea or an acarus should be subjected to a similar process. It is clear that that which would render the larger insect unrecognizable must equally distort and smash out of recognition the smaller one.

Mr. C. Baker, of High Holborn, has undertaken to supply the slides at a reasonable price.

On Some Photographs of Microscopic Writing.

The following letter has been received from Dr. Woodward :—

War Department, Surgeon General's Office,
Washington, D.C., December 29th, 1873.

Mr. John E. Ingpen, F.R.M.S.

Dear Sir,

Two samples of Mr. Webb's fine writing on glass have been received at the Museum since my communication of August 18th. Each consists of the Lord's Prayer, written with a diamond, according to the label, in a space $\frac{1}{294} \times \frac{1}{441}$ of an inch. In one of the slides the writing is blackened and mounted in Canada balsam; in the other it is not blackened, and is mounted dry. I send photographs of both herewith—the one magnified 650 diameters, the other 825. I find Mr. Webb's statement of the dimensions in which this writing is executed to be substantially correct, and he has certainly produced a most curious and interesting object for microscopical study. To compare his work

with the coarser bands of Nobert's plate, I took a photograph of the first seven bands of the 19 band plate with 650 diameters, which I also forward herewith.

This photograph, and that of the blackened writing, were taken on the same day with the same objective, Powell and Lealand's immersion $\frac{1}{8}$th, at the same distance, and under identical conditions. The photograph of the writing was made first, and is the best of a number of trials. I then inserted the Nobert's plate, not even changing the cover correction, as I should have done to secure the best definition, because this would have changed the power. The picture sent was the result.

A comparison of the two pictures will render any remarks on the relative delicacy of Mr. Webb's work and that of Nobert unnecessary. It is evident that the point used by the former is very much coarser than that used by the latter.

The picture of the Prayer, mounted dry, was taken on a subsequent occasion, and is also the best of a number of trials. It is taken with the same objective as the other pictures, but with a different cover correction, and somewhat greater distance.

Both the samples sent me by Mr Webb are inscribed on such thick covers that they are seen under a disadvantage, and my highest powers cannot be used on them. The writing is, however, comparatively so coarse that it can hardly be considered as a serious test for high powers. Either plate is easily read with a good half-inch objective and central light.

I am curious to learn how this writing of Mr. Webb's compares with that of Mr. Peters, described by the late Mr. Farrants in his address as President of the Royal Microscopical Society. He stated that it was executed at the rate of twenty-two Bibles to the inch. I would greatly like to see such a specimen, and give it a photographic trial.

Will you kindly read this note to the Club, and present the photographs? I send also a full set of my last photographic analysis of Nobert's plate for the Club, and a package for Mr. Webb, which I beg you to hand him.

Very respectfully,

Your obedient Servant,

J. J. WOODWARD,

Assistant Surgeon, U.S.A.

(*Read Jan.* 23*rd*, 1874.)

On Insect Mounting in Hot Climates.

By Thos. Curties and John E. Ingpen.

(*Read January* 23, 1874.)

Abstract.

The object of this paper was to bring under the notice of the Club a collection of 146 slides of insects and parts of insects, mounted by Mr. Staniforth Green, of Colombo, Ceylon, and presented to the Club by Mr. Curties; with especial reference to the methods employed in mounting them, by which the objects were preserved in a natural and very beautiful manner. Reference was made to the usual methods of mounting insects, in which much was often sacrificed to the production of showy and attractive preparations, while there was sometimes great distortion of parts and alteration of structure. The well-known object, the proboscis of the blow-fly, was taken as an example, and Mr. Suffolk's remarks upon it, in a paper read before the Royal Microscopical Society in April, 1869, were quoted. Mr. Suffolk had at that time given up the flattening process, and prepared his specimens by soaking recently-killed flies in glycerine, and leaving them until required for examination, when they were mounted in the same fluid in various positions, *without pressure.* Such specimens showed the muscles and chitinous endo and exo-skeleton with considerable clearness.

The methods employed by Mr. Green were then described, and many extracts from his letters read. It appeared that he had for the most part given up soaking the preparations in potash, and those which had been so treated were among the least successful in the collection. Most of the specimens were admirably suited for examination under the binocular, and showed to great advantage with paraboloid illumination. The smaller insects were killed in ether, immediately immersed in Canada balsam, *without pressure,* and exposed for a considerable time to the rays of the sun, by

which treatment they were preserved in the most perfect manner, with total absence of the usual milkiness, and with the various parts in their natural positions. Good examples of this method were in the collection; among them such objects as aphides in various stages of development, on a leaf; a scale-bearing *Psocus* (an insect of great interest); small spiders; the eggs, larva, pupa, and imago of gnats, together on one slide; &c. Larger insects, after being killed in ether, were placed for four or five days to dry between the leaves of a book, with a light pressure, after which they were immersed in spirit of turpentine until all the watery matter was extracted, and then mounted in a very thick film of Canada balsam, which was exposed to the sun until hardened. By this method, the natural forms of the insects were but little if at all altered, and some of the specimens showed eyes, antennæ, tracheæ, and ovipositors most satisfactorily. Generally, care had been taken (contrary to the usual custom) to attain as little transparency as possible, under the idea that the less natural appearances were altered the better. Many of the preparations polarized well, owing to the fact that the muscles were left entire, and not injured by soaking in potash. In some of the letters from Mr. Green which were read, special reference was made to the fact that the natural appearance and characteristics of the insects were really preserved by the methods used. Possibly, part of the success was due to the peculiar action of a tropical sun, which might, perhaps, exercise a greater effect in preserving the parts in a natural state than could be obtained by artificial heat alone. The balsam also seemed somewhat dissimilar from that now used in England, and from its yellowness and toughness, more nearly resembled that employed in the early days of microscopy. The objects were presented to the Club rather as specimens of the successful mounting and preservation of insect structure than as an entomological collection, but, as some of them had been named by Professor Westwood and others, they became of additional value to the cabinet of the Club. With regard to the transmission and preservation of rare and minute tropical insects, Mr. Green's plan seemed to possess great advantages over dry mounting on cards or immersion in alcohol—in fact, specimens could not be kept in the tropics dry for any length of time on account of the white ants, and when sent in alcohol were almost always injured. The objects presented to the Club were in exactly the same state as that in which they were

received, and in some instances the covers were tilted from the uneven thickness of the objects and the avoidance of pressure. This could be remedied in future by the use of cells, and in one case support for the cover was obtained by two slips of thick glass, allowing the free action of the air upon the thick film of balsam, which kept within the limits till hardened. The absence both of air-bubbles and milkiness—even under the searching illumination of the paraboloid, showed how successful were the methods employed, and the preservation of soft parts, as in spiders and aphides, was remarkable. Although the processes described might not be practicable to the full extent in colder climates, they were highly suggestive, and might be the means of preserving many valuable specimens of exotic entomology. The chief points discussed in the paper were—the avoidance of pressure, by which the preservation not only of natural forms but even of characteristic positions and attitudes was insured; the disuse of potash and other solvents, thereby avoiding the deterioration of tissues; the exposure to a tropical sun, instead of artifical heat for hardening the balsam; and the careful abstaining from undue manipulation; all tending to ensure the preservation of the specimens in a natural manner and with a life-like aspect.

On an Improved Method of Mounting Opaque Objects.

By T. Charters White, M.R.C.S., F.R.M.S., &c.

(Read February 27, 1874.)

We have all, doubtless, at one time or another, been annoyed by the dewy deposit that settles on the under side of the thin glass covering specimens intended to be viewed as opaque objects, and having myself experienced this annoyance, I was induced to adopt a plan which will, perhaps, be acceptable to those who may be troubled with this disfigurement. I have for some time been in the habit of covering such objects in a manner which, while it excludes dust and securely fixes the cover, allows me when necessary to remove the glass and wipe off any exhalation that may have settled on it, and replace it as at first. I have given this method a fair trial, and can therefore confidently recommend its adoption by others. I have

been accustomed in mounting any specimen as an opaque object to proceed in the ordinary manner till the time arrives when the covering glass is fixed, when, instead of attaching it to the cell permanently, I merely lay it in its place and fix it by a minute drop or two of the composition I have brought for distribution this evening; the cover is now held in close connexion with the cell, and can be carried about and used with as great safety as if permanently adherent; but with this advantage, it can be removed and replaced as often as may be necessary without any difficulty, and without detriment to the specimen contained in the cell. The nature of the composition is exceedingly simple, being nothing more than four or five parts of the ordinary yellow bees wax melted with one part of Canada Balsam.

Among the other useful purposes to which this composition may be turned, I would mention one or two that may be worthy of consideration. I find it very useful in dry mounting such objects as the scales of Butterflies, Lepisma, or Podura, &c. We all know the troubles of cement running-in in these cases, but this may be entirely obviated by filling in the angle between the edge of the covering glass and the glass slide with this composition, when a permanent cement may be run round without any fear of a particle running in. To do this neatly it is sufficient to melt a little in a spoon and paint round with a warm smooth wire; it then sets directly it touches the cold glass without being drawn under by capillary attraction; without any further addition the slide is sufficiently secure to carry about—it may also be used to fix the covering glass on objects recently mounted in Canada balsam, but which it may be desirable to remove for exhibition at a meeting. Another use to which it may be put is that of fixing on the covering glass, if we are desirous of watching the growth or development of an Infusorian or other form of aquatic life; by drying round the edges of the covering glass and dropping a small portion of the composition here and there round it, it is securely retained in its place, and may be returned to the water from which the specimen was taken, and thus converting the slide into a "growing" slide. It may also be employed to stick glass together to make a temporary zoophyte trough; but I need not occupy the time of the meeting by any further suggestions, for doubtless it may be put to many uses by the practical minds of those present.

On the Microscopic Structure of Flints and Allied Bodies.

By M. Hawkins Johnson, F.G.S., &c.

(*Read February 27th*, 1874)

The great advance made by geology as a science during the last fifty years is due, not to the acuteness of modern observers as compared with their predecessors, but to the assistance they have derived from the advance of other sciences, upon which, indeed, geology is almost dependent. Many are the aids to investigation which it has thus received, and to none of these is it more indebted than to the microscope, which is almost daily revealing new wonders to those who will avail themselves of the assistance it offers.

I have lately been giving my attention to the curious group of bodies commonly known to geologists as nodules. There are nodules of one sort or another in almost all the sedimentary deposits, from the oldest to the most recent; and of whatever material they may be composed, they have been almost invariably described as concretions, a term which, as applied to these bodies, can scarcely be considered explanatory.

To give a list of all that are known would entail my dragging you through a complete course of stratigraphical geology. There are some, however, which are comparatively familiar to us all, such as the Flints and Iron Pyrites of the Chalk, the Septaria of the London and Kimmeridge Clays, the Phosphatic Nodules or Coprolites of the Gault, and the Nodules of Clay Ironstone. These well-known examples are those that I have more particularly examined, and of which I wish to speak.

In my investigation I began by making thin sections, mounting them in and on Canada balsam in a variety of ways, and using both transmitted and reflected light. Of course, I saw what everybody else has seen who has adopted this system, numbers of curious things imbedded in numbers of curious substances; very

interesting, indeed, when first discovered, but all appearing to be foreign bodies intruded into the situations they occupy rather than cognate with the substances that enclose them.

I was very soon dissatisfied with this, as I felt that the bodies imbedded in them threw no light, or scarcely any, on the nature of the nodules themselves. So I reflected upon the matter, and soon saw that, in their own proper substance, either they were homogeneous or they were not. If they were homogeneous a solvent would act equally upon them in every part; if they were not, the solvent would probably act unequally, and possibly throw some light on their constitution. In arranging the experiment, it was obviously advisable to let the action of the solvent be as gentle as possible, but at the same time efficient.

The first examined was a Nodule of black Flint from the chalk, the study of this substance having indeed first drawn my attention to the general group. I cut a conveniently thin slice of it, say $\frac{1}{20}$th inch in thickness, and placed it for about an hour in hydrofluoric acid; then removed it, washed it gently by aspersion with distilled water, and dried it. Originally black and translucent, it was now white and opaque; it could not have undergone any chemical change, the acid merely acting as a solvent, so that the alteration must be due to a change in the physical character of the surface. On examining it by the microscope as an opaque object the appearance presented is what I have shown in this drawing (Pl. IX., Fig. 1), a structure apparently consisting of fibres ramifying in all directions, the organic character of which can scarcely be doubted. This was very striking and suggestive, particularly as I found the same structure to pervade the whole mass almost uniformly.

Having made this discovery, it occurred to me to try similar experiments with other nodules. Accordingly I set to work upon Coprolites, Septaria, and several others. I had no difficulty in finding solvents, dilute hydrochloric acid acting upon them readily. I submitted them to the prolonged and gentle action of this acid, washed, and dried them, and on examination by the microscope was not a little disappointed to find them converted into a sort of mud, cracked in all directions. I repeated the experiments several times, with weaker acid, stopping its action at an earlier stage, but with no better result, and I had almost relinquished the idea, when somehow or other I thought I might as well examine them in the

fluid. I did so, and immediately saw that I had got a beautiful and delicate structure of a most definite character, in the case of the Septaria from the London Clay having the appearance represented in this drawing (Fig. 3).

Being satisfied of the existence of this structure, my next difficulty was to preserve it so as to be able to show it to others at any time, and what with air bubbles, disengagement of gas, shrinkages and leakages, &c., I had so much trouble that I should be ashamed to lay the details of my failures before the Club, although they might possibly be edifying. I found at last the best plan to be to wash carefully, by a gentle stream of water, until all trace of acid was removed, then very gradually to heat the water to boiling, so as to get rid of all air, and to mount in a cell with freshly boiled distilled water. It is necessary to stop the action of the acid while there is still a portion of the solid stone left, as this latter makes a firm foundation for the delicate tissue exposed, which, while it maintains its connection with the part still imbedded, retains its original form unaltered.

The structure thus exhibited has the appearance of a soft mass permeated in every part by anastomosing canals. It is evidently of an organic nature, and suggests very forcibly that great division of the Protozoa, the sponges. The Septaria, from the Kimmeridge Clay, have a very similar structure ; the Clay Ironstone nodules also, which are probably of the same nature as the Septaria, except that the calcium has been partly replaced by iron, present the same appearance ; so also do the Phosphatic Nodules of the Cambridge deposit, and those from the Gault in other places. The structures of these several bodies do not appear to be absolutely identical, but may be said to have a generic resemblance. Of course there are considerable differences of colour.

Having established to my satisfaction the organic character of all these bodies, I was tolerably prepared to see, without surprise, anything whatever ; I was, nevertheless, almost startled when I found that the well-known nodules of Iron Pyrites, so common in the Chalk, and often known as thunderbolts, are not only of organic origin, but that the organic structure is still present in these masses, merely waiting to be uncovered—such is undoubtedly the case. Slices of these nodules ground smooth, and then subjected to the action of strong nitric acid, show this structure in relief on the surface, the bi-sulphide of iron by which it

was surrounded having been removed by the acid. The structure thus revealed is shown in this drawing. (Fig. 4.)

I must not be understood to say that because in the instances I have described the nodules are undoubtedly organic, that therefore all nodules are organic. I wish particularly to guard against this inference. I have shown an organic structure in certain cases, but it would be rash in the extreme to draw from these a hasty generalization as to the nature of the whole group. Nevertheless, the evidence adduced certainly points in that direction.

How these structures have been preserved is a subject upon which I have treated in a paper lately read before the Geologists' Association, but, as it can scarcely be considered microscopical, and I have already taken up a good deal of your time, I will only venture to say that they were silicified by the substitution of silicon for carbon, and the subsequent elimination of the other constituents; and that afterwards the interstices were filled in, either with the same or with different materials, until they were converted into solid compact masses.

I have one other drawing (Fig. 2) to which I wish to call your attention. It represents the microscopic appearance of a piece of flint that has been subjected to a sort of natural injection. The organic structure has been infiltrated with some ferruginous solution, which has subsequently been converted into hydrated sesquioxide of iron. This is by no means uncommon, but, according to my experience, the specimens best adapted for exhibiting the structure are the green-coated flints from the Bull Head bed, between the Thanet Sand and the Chalk. When a very thin polished slice of such a flint is viewed as an opaque object the oxide of iron appears of a light brown or buff tint, in striking contrast to the transparent silica not infiltrated, which of course appears black. The structure thus displayed is the complement of that developed by hydrofluoric acid, the latter being only a mould or impression, while the former may be said to be a natural injection of the organic structure itself.

On the Histology of Plants.

By R. Braithwaite, M.D., F.L.S., &c.

IV. The Different Kinds of Cells.

(*Read March 27th*, 1874.)

Having followed the vegetable cells from the homogeneous spherical condition through various stages of differentiation, we have next to consider them in their finished or perfect form. Many names have been introduced—especially by Nägeli—for the various kinds of cells, but often unnecessarily, as for instance *Sclerenchyma*, when they have become thickened and indurated; but as all cells may undergo this physiological change it is clear it possesses no distinctive character, for it applies to wood, to the stony concretions of the pear, to the dark bundle in the rhizome of the brake, and many other tissues.

We may more simply classify them by the structure of the cellulose case, and their mode of connection with each other, and thus they readily fall into three groups—*Parenchym cells*, *Fibre cells*, and *Tubular cells*, which we may not inaptly compare to the flesh, bones, and vessels of animal bodies.

I.—Parenchym Cells.

These include all spherical, polyhedral, or prismatic cells, which are applied to each other by their cellulose case, and having their walls homogeneous or variously thickened, and only rarely provided with bordered or sieve-like pores. The term *Parenchyma* has often been restricted to those cells which have flat ends, while those with pointed extremities have been named *Prosenchyma*.

Parenchymatous cells constitute the entire substance of Fungi, Lichens, Algæ, and the greater part of mosses; in the higher plants all homogeneous tissues, as pith, bark, and cuticle, and in the heterogeneous tissues they are combined with the other two forms in all vascular plants. Thin walled Parenchym cells are of most frequent occurrence, and assume many different forms. The

cellulose case is homogeneous in the spores of Fungi and Algæ, leaves of mosses and Hepaticæ, &c., or with secondary thickening layers which take an annular, spiral, or netted arrangement, and may also be perforated by closed pores. These cells are coloured blue by chloro-iodide of zinc, or by iodine and sulphuric acid, but occasionally they become lignified, as in the pith and petiole of palms, and medullary rays of oak, fir, &c.; the iodine then stains them yellow, except the cellulose membrane closing the pores, which is coloured blue, thus showing that it is not lignified, and no doubt on this account retains its original capacity for the diffusion of fluids throughout the tissues.

Thickened Parenchym cells are much rarer, but occur in the collenchyma and seed albumen of many plants, and more or less lignified in pith and bark, and in some fruits.

Collenchyma cells lie under the epidermis, are thin walled and polyhedral, have usually a thickening deposit in the angles, and appear waxy on section, but evidently laminated; they may be seen in the stems of sorrel, and many umbelliferæ. Strongly thickened, unlignified Parenchym cells occur in the albumen of the seeds of lilies and palms, in the coffee berry, ivory nut, date stone, and the seed of *Ceratonia siliqua*, or Carob bean.

Lignified Parenchyma is well seen in the pith of *Clematis vitalba*, and in the pith and bark of *Hoya carnosa;* the cells are usually cubical, and often pierced by branched pore-canals. Similar cells are also found in the bark of laburnum, ash, *Ficus elastica*, &c., and of a more irregular form in the bast of beech and birch, in the shell of the almond, walnut, and Brazil nut, and also in the stony concretions of winter pears; the thickening often completely obliterating the lumen of the cell. After heating with liquor potassæ the iodine tests colour all the layers yellow.

II.—Fibre Cells.

These are almost entirely confined to the vascular bundles, and hence are found in wood and bast tissue, but very rarely in pith or bark. They are distinguished by their great length, and touch each other on all sides, with more or less oblique faces, so that in outline they are fusiform, pyramidal or conical, and have very rarely any transverse partitions, but we find such in the branched bast cells of Euphorbia. Fibre cells are usually simple, and always more or less thickened, with the secondary and tertiary

laminæ distinct. The thickening is greatest in bast tissue, and in it also the secondary layers are most distinct, those of wood cells being more homogeneous, and pores are also usually present. A small wide-turning spiral band is seen near the bordered pores in wood cells of yew, vine, mezereon, *Viburnum Lantana*, &c., and with narrower turns in the wood of *Pinus picea*. Broader spiral bands are observable in the outer wood cells of the annual ring of conifers, and the striation is more sharply defined by application of nitric acid. When unlignified, as in *Apocynaceæ* and *Asclepiadaceæ*, the iodine tests produce on the laminæ the usual blue reaction.

III.—Tubular Cells.

These also occur only in the vascular bundles, and belong partly to the wood, partly to the bast portion. In form they are usually elongated cylinders, and are distinguished from long parenchym cells and from fibre cells by their oblique transverse partitions, which endure only so long as they carry sap, but as soon as the liquid contents become replaced by air, these partitions are resorbed, or if they should remain, their structure is different from that of the longitudinal wall.

The perforation of the transverse partition takes place in various ways; in those vascular cells of the woody bundles in which the partitions are horizontal or but slightly oblique, the opening is usually a large bordered pore, as we see in the oak, ash, or beech, and not unfrequently reticular as in *Pteris aquilina*. If the partitions are still more inclined to the longitudinal wall, we find many round or longish pores, producing netted or scalariform perforation as in *Ephedra*, *Lonicera*, *Viburnum*, &c.

Thickening of tubular cells occurs under various forms, but it never attains to the extent met with in fibre cells. We have ring-like thickening in the annular vessels of the medullary sheath of Gymnosperms and Dicotyledons, and they may be seen adjacent to the spiral vessels in the vascular bundles of monocotyledons and ferns; in the stems of maize, reeds, and *Balsamina* they are well developed.

Spirally thickened tubular cells, spiral vessels or *Trachenchyma* are equally common in the medullary sheath of Dicotyledons, the most internal cells having very wide turns of the spiral band, in consequence of this part of the vascular bundle being in most active growth, the spirals become more quickly drawn apart. The

direction of the spirals is most frequently to the left, and their number in each cell is variable, while the transition from annular to spiral thickening is not unfrequent even in the same vessel.

Tubular cells with net-like thickening are best seen in succulent herbaceous plants, such as Balsam, Cucumber, and Celandine, and they lie more external than the spiral cells.

Porose tubular cells (Pitted tissue or *Bothrenchyma*) are widely distributed, the pores being bordered, and circular or slit-like. Round-bordered porose tubular cells form the greater part of the vessels in Dicotyledons. When the border is extended considerably in a transverse direction, we have the so-called *scalariform vessels*, familiar to you all in the vascular bundles of ferns, and also seen in the stems of the Vine, Balsam, Viburnum, Daphne, &c. The thin transverse partitions are perforated by a single pore, or by net-like or scalariform apertures; mixed spiral and porose tubular cells are seen in the Lime and Honeysuckle.

Porose tubular cells with cribriform thickening (Lattice cells) pertain only to the bast portion of the vascular bundle, and to this group also belong the milk vessels, which carry the coloured sap or latex in many plants. The transverse partitions open by a single large pore, the covering membrane of which is not resorbed, but becomes perforated by roundish or angular apertures, so as to resemble a sieve or grating, as we see in the Hop, Bryony, Dahlia, *Equisetum*, &c.; or when the partition is much inclined, the perforations are lattice-like, as in *Pteris. Tilia*, *Œsculus*, &c.

Complete resorption of the transverse partitions has taken place in the branched anastomozing tubular cells which constitute the milk vessels, so general in composite plants, *Euphorbiaceæ* and *Asclepiadaceæ*. The cellulose case of their longitudinal walls is usually weak, but strong thickening layers are seen in those of the tropical Euphorbias. The thin places consist of large pores, the partition wall of which is, by resorption of the closing membrane, variously perforated by smaller pores. The cribrose cells are enclosed by the fibre cells, and equal them in length, attaining their greatest dimensions in the milk vessels of *Apocyneæ* and *Euphorbiaceæ*, on account of the union of several cells into one tube. Lignification takes place but to a slight degree, so that Iodine always gives the reaction of cellulose, and, to observe the milk vessels, long maceration is necessary until they become isolated by decay of the softer tissues around them.

Thus we find each kind of cell is constructed so as best to carry on its appointed function; where freedom and quickness of circulation are required, as in the milk-vessels of such plants as the sow-thistle, lettuce, and celandine, the walls are thin, and all obstructing partitions are removed; on the other hand, where strength is needed, as in so many fibres used in our manufactures, deposit goes on in the interior until hardly any central space is left, and if firmness and resistance are required, this deposit becomes so indurated as to give those qualities we value in such woods as oak, mahogany, box, and ebony; while even in them provision is made for interchange of air and fluids by the beautiful pores and canals already referred to.

Illustrative Figures.

Plate X.

Fig. 1.—Albumen cell from Date-stone, seen under water. × 400.

Fig. 2.—Lignified Parenchym-cell from shell of Walnut, with branched pore-canals. × 660.

Fig. 3.—Fibre cell from wood of *Pinus Picea.* × 125.

Fig. 4.—Ditto from bast of Larch. × 125.

Fig. 5.—Fibre cell from wood of Yew with bordered pores and spiral band. × 400.

Fig. 6.—Net-like perforation of partition wall of vessel in *Lonicera caprifolium.* × 400.

Fig. 7.—Spirally thickened tubular cell from Dahlia. × 370.

Fig. 8.—Part of a so-called Scalariform vessel from *Pteris aquilina. p. p.* the net-like perforation of the transverse wall. × 370.

Fig. 9.—Transverse partition in *Cucurbita pepo. A.* in longitudinal section, *c.* the cellulose case; *m.* the cell membrane; *t.* peculiar thickening; *e.* contents contracted. *B.* in transverse section; at the upper part the deposit projects like papillæ.

Fig. 10.—The same from *Fagus sylvatica.*

PROCEEDINGS.

January 9th, 1874.—Conversational Meeting.

The following objects were exhibited:—

Shell on Zoophyte	By Mr. E. Bartlett.
Insects mounted whole	Mr. G. K. Coles.
Larva of *Ephemera*	Mr. Dunning.
Water-weed mounted in Spirit for 20 years ...	Mr. Glasspoole.
Section of Human Scalp	Mr. Goodinge.
Diatoms selected by Mr. Kitton	Mr. Hailes.
Glass Cells ground by the Sand-blast Process ...	,, ,,
Sulphate of Copper and Magnesia	Mr. Hind.
Specimens illustrative of the Microscopical Structure of Flint	Mr. M. Hawkins Johnson.
Iris of Dragon-fly	Mr. McIntire.
Daphnia Pulex	Mr. Martinelli.
Human Fœtus, one month old	Dr. Matthews.
Sertularia with *Spirorbis*	,, ,,
Immersion Tube for the Aquarium	Mr. Richards.
Whisker of Lion (Polar)	Mr. Underwood.
Section of Eye of Drone-fly	Mr. A. Waller.
Gemmules and Spicules of Sponge in Flint ...	Mr. J. G. Waller.
Hydractinia and *Vaginicola valvata*	Mr. T. C. White.
Leaf of Scale-fern	Mr. Geo. Williams.

Attendance—Members, 54; visitors, 14.

January 23rd, 1874.—Dr. R. Braithwaite, F.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following donations to the Club were announced:—

"The Monthly Microscopical Journal"... ...	From the Publisher.
"Science Gossip"	,, ,,
"The Popular Science Review"	,, ,,
"Proceedings of the Royal Society"	the Society.
"Proceedings of the Geologists' Association"...	the Association.
"Proceedings of the Literary and Philosophical Society of Manchester"	the Society.
"Annual Report of the Brighton and Sussex Natural History Society"	the Society.
"Suffolk on Spectrum Analysis, as applied to Microscopical Observations"... ...	the Author.

"Davies on Mounting"	Mr. Tafe.
"Lancaster's Half-hours with the Microscope"	"
A number of Photo-Micrographs, including two of Mr. Webb's specimens of Microscopic Writing and a companion photograph of the first seven bands of Nobert's Test Plate, taken with the same objective	Dr. J. J. Woodward.
One Slide	Mr. Walter White.
146 Slides of Insects, mounted by Mr. Green, of Ceylon	Mr. Curties.
"The Quarterly Journal of Microscopical Science"...	By purchase.
Dr. Beales' "How to work with the Microscope"	" "

The thanks of the Club were voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. E. M. Doble, Mr. E. H. Flux, Mr. J. H. Hadland, Mr. J. D. Hardy, Mr. R. Moreland, jun., Mr. H. E. Newton, Mr. G. Pearce, Mr. J. E. Taylor, and Mr. C. H. Wright.

The Secretary read a letter received from Dr. J. J. Woodward, of the Army Medical Department, Washington, relative to the photographs which he had kindly presented to the Club.

The thanks of the meeting were voted to Dr. Woodward for his communication and contribution.

Mr. H. F. Hailes read a paper "On a new form of Deep Cell, made by the Tilghman Patent Sand-blast Process." (See page 227.)

A vote of thanks to Mr. Hailes for his communication was duly carried, the President observing that this appeared to be the first practical application of the Sand-blast Process to microscopical purposes.

Dr. Matthews wished to say a few words, which, though almost personal, were simply a matter of justice to Mr. T. C. White. He (Dr. Matthews) had been honoured with a commission to edit a new edition of "Davies on Mounting." It appeared that, after leaving his hands, the publisher had let Mr White see the sheets, and then he had afterwards passed them on to Mr. Davies. It also appeared that Mr. White had made some additions to the work, unknown to him, and as these additions by Mr. White had added much to the value of the work, he took the present opportunity of publicly acknowledging his indebtedness to Mr. White in the matter.

The Secretary read a description, by Mr. Richards, of his "Improved Immersion Tube," for viewing objects under water. This consisted of a tube of brass with a plain glass cemented to one end, and capable of sliding over an inner tube, having the universal screw at each end; the latter was screwed into the microscope body, and an objective screwed to the other end. The immersion tube was then slid over it for the distance required by the objective used and the depth of the aquarium.

The thanks of the meeting were voted to Mr. Richards, and the President remarked that the tube was likely to be useful in observing objects under water, and, as it could be used at a considerable depth, it would be suitable for the examination of *Sertularia*, &c.

Mr. Ingpen read a paper, by Mr. Curties and himself, "On Insect Mounting in Hot Climates," with especial reference to the valuable collection of objects

mounted by Mr. S. Green, of Colombo, Ceylon, and presented to the Club by Mr. Curties.

The President, in proposing a vote of thanks to Mr. Curties and Mr. Ingpen, expressed his sense of the value of the collection, and thought that if anything the smaller were more beautiful than the larger ones. Many were of minute diptera, which had long antennæ, and he thought that if they were disturbed they would almost certainly be displaced or destroyed.

Votes of thanks to Mr. Curties and Mr. Ingpen were carried unanimously.

Mr. Curties said that the object which he and his friend Mr. Green had in view was to present the collection to some public body by whom the question as to the best means of preserving and transporting such objects could be worked out. As to the specimens which had been sent over in spirit it had been found that the results were not entirely satisfactory, and they had, therefore, endeavoured to ascertain some better method of sending them. On receiving these parcels he thought that objects sent in this manner might be utilised by reason of their perfect preservation in a natural form. Many friends went abroad, and came back bringing nothing with them from inability to preserve specimens, and any improved methods of doing so must be of value in scientific research.

Mr. Loy stated that having looked over the collection he could speak favourably of the results attained. He had paid more attention to the smaller insects than to the larger ones, and many of them appeared to have been simply dropped into the balsam without preparation. Instead of finding them at all cloudy, they were quite clear, and there were very few air-bubbles. The muscles of the thorax and legs were shown beautifully, and in some of them the small intestines and hepatic vessels could be clearly traced. He thought that if they could succeed in doing in England what had been done in the tropics, it would be worth much trouble. A few of the parasites had been soaked in potash, but the results were not so satisfactory. He was surprised to find that insects merely pressed between the leaves of a book should be so free from air-bubbles. The question was whether it was possible to do the same here as in the tropics; or whether the sun there did not have the power of driving out the moisture much more completely than was possible with artificial heat in our own climate. He had himself a slide mounted—a section—from which it seemed impossible to drive the moisture, although it had been placed for several months on the top of a cistern filled with hot water. As regarded the various methods of sending insects from foreign parts, a friend of his in Belgium received some which came perfectly safe in castor oil; he expected to be able to get it all out, and to mount the insects perfectly.

Mr. B. T. Lowne thought they could hardly expect many persons to take so much trouble in this matter as Mr. Green had done. There was, however, a very easy way of transmitting small insects, and that was by merely placing them upon a piece of gummed paper, and laying it out to dry. If they were not subjected to pressure they would come quite safely, and could be got off for use by re-dissolving the gum. The great difficulty, he thought, had been that of getting insects sufficiently unchanged for examination of their internal organs, which usually became impregnated with fatty matter to such an extent as to make them worthless for this purpose. Whether they were put up in oil or in glycerine this fatty matter was found to change the whole so entirely that after a few years they became totally useless, and it was possible only now and then to get a glimpse of the internal organs in consequence.

Mr. Ingpen remarked that Mr. Green stated in one of his letters that he could

not keep insects *dry* because of the white ants, and this led him to put them into balsam.

Mr. Curties said he was under the impression that Mr. Lowne's plan had been adopted, but that this one was attempted as an improvement upon it, and in order that the objects might be utilised for future observation both of form and structure.

The President thought that there were two objects in view, and that Mr. Lowne's was the one likely to be taken by a systematic entomologist rather than by a microscopist.

Mr. McIntire said that some time ago Mr. Curties showed him a number of these slides, and he was very much struck by many of them. They seemed to throw much light upon some subjects of interest to him. The gnats were the only diptera found here with scales on their wings, but in this collection there were other diptera with scales. There were also several slides of *Podurœ*, but they seemed the same as *Degeeria Domestica*. As to mounting insects in balsam at once, it was a plan which he was very much in favour of; they should be killed in spirit and then transferred at once to soft balsam. A little dirt would sometimes get in, but this was less detrimental than some of the effects of mounting in the usual way.

Dr. Matthews recommended the use of benzole in cases where the object was subject to adiposere. Balsam could be dropped into it, and so it might be used as a medium.

The Secretary read a letter from Mr. Joseph Bell, of Hetton Colliery, near Durham, asking for information and assistance in establishing a Microscopical Club amongst the mining population of that district, and stated that the information asked for had been sent by him in the name of the Club.

Announcements of Meetings, &c., were then made, and the meeting terminated with a *conversazione*, at which the following objects were exhibited :—

Various Foraminifera	By Mr. Bartlett.
Parasite of Horseshoe Bat (Ceylon)	Mr. Curties.
Spiniferous Tubercles of Lingthorn	Mr. Dunning.
Gizzards of two Fleas	Mr. Glasspoole.
Polycistinæ	Mr. Hind.
Tank Microscope	Mr. Richards.
Ova of Toad in different stages of development	Mr. Topping.

Attendance—Members, 90; Visitors, 17; total, 107.

February 13th, 1874.—Conversational Meeting.

The following objects were exhibited :—

Tick of Aard-vark (*Orycteropus Capensis*) ...	Mr. Curties.
Sand-blast cell and examples of mounting ...	Mr. Hailes.
Achromatic Bull's-eye Condenser	Mr. Ingpen.
Palate of Whelk	Mr. Martinelli.
Zoophytes in Fluid	Dr. Matthews.
Section of Cat's lip (polar)	Mr. Moginie.
Ovary of Rabbit—stained section	Mr. E. T. Newton.
Frog's bladder	,, ,,
Various Brazilian Beetles	Mr. J. A. Smith.
Lung of Salamander	Mr. Topping.

Seed-capsule – *Lunaria biennis*	Mr. Underwood.
Section of leaf of *Ficus elastica*	Mr. Ward.
Enchondroma	Mr. T. C. White.
Diaptomus Castor (alive)	Mr. Geo. Williams.
Wright's Electro-magnetic Turn-table	Mr. E. Wright.

Attendance—Members, 60; Visitor, 1.

February 27th, 1874.—Dr. R. Braithwaite, F.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following donations to the Club were announced :—

"The Monthly Microscopical Journal" ...	from the Publisher.
"Science Gossip"	,, ,,
"Proceedings of the Royal Society"	the Society.
"Proceedings of the Literary and Philosophical Society of Manchester."	the Society.
"The American Naturalist," Dec. and Jan.	in Exchange.
"Microscopical Examinations of Air," by Dr. Douglas Cunningham, Indian Medical Service.	from the Author.
"Proceedings of Geologists' Association" ...	the Association.
Ten Slides	Mr. Watkins.

The thanks of the Club were voted to the Donors.

The President said that it would no doubt be remembered that some time ago two gentlemen, Mr. Horncastle and Mr. Crisp, had presented the Club with sums of money amounting together to £8. The committee thought that the best use they could make of this would be to procure such books for the library as should be of real value to the members. The opportunity occurred of purchasing some valuable works from Mr. Cooke, and it was intended to inscribe them as having been presented to the library by the two gentlemen who had given the money.

The following is a list of the works thus added to the library of the Club :—

Bailey, Microscopical Examination of Soundings of Atlantic Coast.	1851
Brady's Recent British Astracoda (*Linn. Trans.*)	1868
Brady, Parker, and Jones, Genus *Polymorphina (Linn. Trans.)* ...	
Brown, J., Foraminifera from the Colne Tidal River	1856
Busk's Polyzoa of the Crag	1859
Carter, H. J., *Squamulina* and *Difflugia*, New Species of	1870
D'Orbigny, Foraminiferes du Bassin Tertiare de Vienne	1846
Egger, Foraminifera, from the Miocene of Ortenburg	1857
Ehrenberg, Sud-ocean forms, &c. ... ... - ...	1857-8
Jeffrey's Fourth Report on Shetland Dredgings	1867
Jones, T., Rupert, Entomostraca of the Cretaceous Formation ...	1849
,, ,, Tertiary Entomostraca	1856
Karrer, Foraminiferen Wiener Sandsteins	1865
,, ,, ,, Beckens	1864
,, ,, Kosteg in Banat	1868
Mantell's Foraminifera of Chalk and Flint	1846
Mechelin's Iconographie Zoophytologique	1840-7

Parfitt, Protozoa of Devonshire, &c.	...	...	...	...	1869
Parker and Jones, Foraminifera, Coast of Norway	...		...	...	1857
Reuss, Foraminiferen Crag d'Anvers	...	...	...	...	
,, ,, der Septarienthrones von Berlin			...	...	1851
,, ,, Kanara See	...	...	...	...	1865
,, ,, Deutschen Oberoligocäns		...	...	...	1864
,, ,, Westphalischen	...	...	...	...	1860
,, ,, Lagenideen	...	...	...	...	1862
,, ,, Oberburg in Steiermark		...	...	...	1864
,, ,, des Deutschen Septarienthrones			...	...	1866
Seguenza, Foraminifera of Messina	...	...	...	...	1862
Terquem, Foraminiferes du Lias ..	...	...	...	...	1862–6
Weaver, Composition of Chalk Rocks, &c. ...		...	...	...	

A letter was read from the Secretary of University College, granting permission to the Club to hold its meetings in that building during the present year, and also to hold the Annual Soirée on the 17th April.

The warm thanks of the Club were unanimously voted to the authorities of the College for the continuation of their generous liberality in allowing the free use of the building for the meetings.

The following gentlemen were balloted for, and duly elected members of the Club:—Mr. Thos. W. Burton, Mr. Jas. Cornish, Mr. L. May, Mr. Wm. Payne, Mr. Jas. Russell, Mr. J. C. Walker, and Mr. William Wilson.

Mr. T. C. White read a paper on "An Improved Method of Mounting Opaque Objects" (printed p. 232 *ante*).

The thanks of the meeting were voted to Mr. White for his communication.

Mr. T. C. White read a letter from Mr. Furlonge, describing "Certain remarkable organisms observed in the rat flea." The specimen to which reference was made was exhibited in the room under the microscope.

The President, in moving a vote of thanks to Mr. Furlonge, made some remarks differing from the view taken by him; and Mr. Lowne also considered that Mr. Furlonge was in error. The matter stood over for further investigation.

Mr. M. Hawkins Johnson read a paper "On the Microscopic Structure of Flint and Allied Substances" (see p. 234 *ante*). The subject was illustrated by coloured diagrams.

The thanks of the meeting were unanimously voted to Mr. Johnson for his paper.

The President observed that the appearance presented by the objects shown on the diagrams very strongly resembled the remains of sponge.

Mr. T. C. White said he had taken great interest in this subject, and had certainly seen many evidences which led him to suppose that the remains found in flints are those of sponges. He had one section which abounded with spicules and gemmules of sponge. He inclined strongly to the view that flints were silicified sponges.

Mr. J. G. Waller said that the flint question was a difficult one, and had been often discussed. He noticed that although Mr. Johnson's ideas appeared to differ from those of Dr. Bowerbank, yet they pointed to the same conclusions. He had examined Mr. Johnson's specimens, and thought that if their origin were organic, it must have been the sarcode of the sponge. He believed that he had seen something of the kind in the sarcode of a living sponge, but could not pronounce any positive opinion.

Mr. B. T. Lowne had not the least hesitation in referring these bodies to organic structures and sponges. When they knew that the bed of the Atlantic was at the present time depositing chalk, and that there were sponges being enclosed in these formations, he was not at all surprised at finding within flints of earlier formations the remains of sponges also.

The President inquired of Mr. Johnson if he had found any diatoms in any of his flint sections?

Mr. Johnson stated that he had not yet met with any specimen containing diatoms, but only Foraminifera and Xanthidia; these were found in nearly all specimens.

Mr. Waller said there was much in favour of the sponge theory. He had himself never found any flints which did not contain the remains of sponge. The gemmules of sponge were often remarkably well seen in the flints which were picked up on Blackheath; one of these was so clearly marked that he had sent the specimen to Mr Quekett.

Mr. Johnson thought the actual origin was to be sought in the process of the substitution of silicon (silicate of soda) for the carbon of the organic matter. Any organic matter, under favourable conditions, would, if it contained carbon, undergo the change; its decomposition would take place by a slower process. Some time ago he had made an experiment to test this. He put a number of soft-bodied animals into a solution of silicate of soda, and left them there for four or five days. At the end of that time he took them out, washed off all the superfluous silicate, and put them into a quantity of strong nitric acid. He found that the acid had no effect whatever upon them, whereas those which had not been put into the silicate were disintegrated and dissolved by the acid in the course of half an hour. This showed that a great change had taken place, and that silicon had been substituted for carbon. Traces of nitrogen and carbon were occasionally met with in flints.

Mr. Lowne thought that Mr. Johnson's last remarks were of very great importance, and he hoped they would be followed up so as to make certain as to this substitution. Why not put something containing carbon into the solution, and afterwards incinerate it, and thus ascertain how much silica had been absorbed? If this substitution took place, it must of course be from a medium which contained silica in solution, and they would have also to believe that dead protoplasm could collect it from great distances. The objection which he saw to foraminifera was that they naturally collected lime and not flint; but there was another class of creatures very likely to be mistaken for foraminifera —the Radiolarians—which were very common, and which did collect flint in large quantities. Again, as regarded foraminifera, they lived on the sponges, and were found everywhere else; so that it was easily understood how they might frequently get enclosed in the mass. Another fact worth naming was that the mass of flint having been originally deposited as a secretion, lime and other substances would become agglomerated with it. He remembered being much struck the summer before last at the number of half-changed flints which he had found on the downs to the north of Worthing.

Mr. T. C. White said he had been much struck by the appearance presented by a piece of chalcedony which he had rubbed down, and afterwards mounted in balsam. The remarkable resemblance of the ramifications to those seen in a sponge was most striking; only in the case of the chalcedony they were all hollow, or tubular.

Mr. Johnson thought it more probable that the foraminifera were the food of

the sponge than that they fed upon it; this would, no doubt, account for their presence there. He then drew upon the black board a diagram illustrating the chemical changes which he supposed to occur during the process of substitution to which he had previously referred.

The meetings for the ensuing month, and the names of the gentlemen proposed for election at the next meeting, were then announced, and the proceedings terminated with a *conversazione*, at which the following objects were exhibited:—

Anguinaria Spatulata	by Mr. Bartlett.
Marine Polyzoa (*Bowerbankia*)	Mr. G. Cocks.
Rat Flea, with curious filamentous extrusions...	Mr. Furlonge.
Pollen of Hazel, showing pollen tubes	Mr. Glasspoole.
Canthocampus Minutus (alive)	Mr. Martinelli.
Freshwater larva (sp. ?)	Mr. J. A. Smith.
Foot of *Dytiscus* (opaque)	Mr. Topping.
Santonine	Mr. C. Underwood.
Alimentary Vessel of Blow Fly	Mr. Watkins.
Section of Flint, showing triradiate spicules and gemmules of Sponge	Mr. T. C. White.
Canthocampus Minutus (alive)	Mr. G. Williams.

Attendance—Members, 87; Visitors, 7. Total, 94.

March 13th, 1874.—Conversational Meeting.

The following objects were exhibited:—

Bowerbankia Ophiocoma and other forms of marine life	By Mr. Curties.
Section of eye of Drone-fly	Mr. Dunning.
Septaria from the London Clay	Mr. M. Hawkins Johnson.
Iron Pyrites from the Chalk	,, ,,
Clay Ironstone from the Coal Measures... ...	,, ,,
(All treated with dilute acid to show the silicified organic structure.)	
Euglena viridis (alive)	Mr. Martinelli.
Serpula contortuplicata	Dr. Matthews.
Sections of Spinal Cord, cut to $\frac{1}{1000}$ of an inch ...	Mr. E. T. Newton.
"Tasting Cups" from tongue of Rabbit ...	,, ,,
Spores and Threads of *Trichia*	Mr. Oxley.
Section of Leaf of *Oncidium*	Mr. Topping.
Medulla spinalis	Mr. Ward.
Pleurosigma angulatum	Mr. G. Williams.

Attendance—Members, 65; Visitors, 5.

March 27th, 1874.—Dr. R. Braithwaite, F.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following donations to the Club were announced:—

"The Monthly Microscopical Journal" ...	... From the Publisher.
"Science Gossip"	" "
Paper, "On the Nature and Formation of Flint and Allied Bodies," by M. Hawkins Johnson	the Author.
"Proceedings of the Literary and Philosophical Society of Manchester" ...	the Society.
"Annual Report of the Geologists' Association"	the Association.
"Report of the Smithsonian Institution" for 1871	the Society.
"The Lens"	... In exchange.

The thanks of the meeting were voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. Richard J. Beach, Mr. Frederick E. Leefe.

The President announced that the Excursion Committee had completed their arrangements, and that the list of places to be visited during the ensuing season was ready. The first excursion (for April 11th), to Snaresbrook, would afford an opportunity of obtaining many interesting objects for exhibition at the forthcoming Soirée.

Dr. Matthews having taken the chair *pro tem.*, a paper was read by Dr. Braithwaite, "On the Forms taken by Cells in their Finished State." This paper was in continuation of the series on "Cell Growth," and it was intimated by the author that he expected to complete the subject in two more papers.

Dr. Matthews, in proposing a vote of thanks to the President for his paper, observed that the subject, although appearing to be of the most abstruse kind, yet laid at the root of plant histology, and Dr. Braithwaite had treated it in a most exhaustive manner.

The thanks of the meeting were unanimously voted to Dr. Braithwaite for his paper.

Mr. E. T. Newton read a paper "On Section Cutting Machines," and illustrated it by the exhibition of a large collection of them.*

A vote of thanks to Mr. Newton was carried unanimously.

Mr. R. B. Miller stated that he had been using Dr. Rutherford's machine, both in its old and new forms, and he thought that the objection raised to the new machine on account of its size was one which would hardly hold water, because very often the machine was wanted large in the bore—indeed, for anatomical purposes this was frequently essential. He did not like a glass plate, because of the edge; if the edge of the hole were bevelled the wax would be liable to break away in consequence of the gap, whilst if there were no space, the razor might cut on to the edge, and so spoil its own. He ventured to say that a steel plate would be liable to rust, and that the rust could not be cleaned off without much trouble; but he found that a cast-iron plate was better, because it could, when rusted, be easily cleaned with a little emery. Freezing was a plan of Dr. Rutherford's, and was exceedingly useful where a tissue was soft and too large to be cut by hand. A tumour, for instance, was a very difficult thing

* The publication of this Paper is unavoidably postponed.

to cut sections from properly; but when frozen it could be cut without any trouble. He had found a saturated solution of gum with a few drops of camphor added to it to be a good medium, as the gum did not splinter up when cut. Pounded ice and salt were used as a freezing mixture. The box containing the freezing mixture need not, he thought, be on both sides of the machine. He did not use the indicator himself, nor did he place a high value upon it, but rather preferred to trust to the touch. He thought that the $\frac{1}{8000}$ in. which had been mentioned, would certainly spoil most anatomical tissues, for the size of the blood disc, which might be taken as the anatomical unit, was the $\frac{1}{3000}$ of an inch, and a section thinner than that was not often of use. As to the razor, he liked it best with a straight edge and a blade narrow at the point and broad at the heel. He did not think it possible to cut a good section merely by a push; the cut must be made obliquely, and no machine could give the obliquity with such precision as the hand. The so-called American machine was really the invention of Van Hausen, of Kiel. In the matter of hardening, he did not think that absolute alcohol was necessary; indeed, methyl alcohol was preferable, if it was intended to mount in balsam. There was a little water in it, but this did not matter, as evaporation took it off. For staining, Dr. Beale's carmine was now almost always used. Success in staining depended upon taking the tissue out of the hardening solution at exactly the right time. He had seen it done in three quarters of an hour. It was advisable to remove as much of the chromic acid as possible first.

Dr. Matthews said that the first requisite in section cutting was to have a firm support. All wax in cooling shrunk away, and in some cases to such an extent as not to imprison the object with sufficient firmness for the purpose. Specimens of spinal cord would sometimes even turn round in it. This might partly be obviated by using paraffin wax in preference to bee's wax. Then as to the material for the plate, it was a well-known axiom in mechanics that dissimilar metals should always be used for friction upon each other; so that according to this, brass or gun metal should be used, although they had been said to fail, because, if the curved edge of the cutting instrument were in the slightest degree depressed too much, it caused the plate to be cut into. Another cause of this was that the blade of the razor was often slightly flexible; this would give it a tendency to dip and cut into the plate, and would cause its edge to impinge upon the edges of the aperture. The exact thickness of the section, after soaking in alcohol, could never be relied on. He believed that many false appearances had been produced by alcohol and chromic acid; in preparations illustrating sclerosis it was found that some alterations which took place were not the result of a pathological process, but the effect of the hardening by alcohol. In staining, the great principle to be remembered was that the fluid must be alkaline.

Dr. George Hoggan said that as he came almost direct from the College of France, it might be of interest to the meeting to hear what methods were adopted there at the present time. Judging from the opinions expressed that evening, wax had apparently been settled upon as the best substance for imbedding the tissue; he considered, however, that carrot was for this purpose far superior to wax. The pith of the elder was better still; and, indeed, he believed this to be the best of all. For hardening tissues, they placed most reliance in France upon a saturated solution of picric acid. They would place such a substance as a tumour in methyl alcohol for 48 hours, then in the picric acid solution for 48 hours, then in a solution of gum, of the consistency of syrup, for 48 hours, and then in the original alcohol for 48 hours, and for any time

afterwards it would be found to cut like a piece of cheese. The sections should be placed in water for at least 48 hours to clear them from the acid. Chromic acid was certainly the best medium to use for nerve fibres, for though alcohol and other things did pretty well, they did not show the axis sheath so well as chromic acid. For staining, they used picro-carminate of ammonia (four grains of carmine to 100 parts of saturated solution of picric acid). Special care must be taken that this is not used alkaline. Glycerine was almost universally used for mounting in France; a little melted paraffin was run round the edge of the covering-glass, and a solution of sealing-wax painted over it. As to section cutting machines, he did not know who was really the inventor of the one before them, for they had it under many names; the wedge machine was also to be found in Paris. He was himself the inventor of one which he believed to be superior to all others; and it was valuable alike for hard or for soft substances. It would cut a section of a tooth in three minutes, and then on the soft side any sort of material could be cut, even although it might not be homogeneous. His machine was in use in Edinburgh, and it was exclusively used at the College of France. Section cutting in future would have to be done in the opposite way to the plan now adopted, and a number of small cuts must take the place of a single sweep. He had omitted to mention another substance which was used in France for staining, namely, picro-carminate of indigo; it gave a green colour, and was found to answer well for cells and fibrous tissues. These were some of the latest ideas on the subject from the Continent, and he hoped they might be of interest.

Mr. C. S. Rolfe said he had brought to the meeting a machine almost like the "Science Gossip" machine, but with the wedge propelled by a screw, instead of by a blow; this brought it more under control. He had first used it with a brass plate, but had since added a glass plate, and found it to be an improvement.

The President expressed his thanks to Dr. Hoggan for the information which he had communicated, and hoped that he would be able, at some future time, to show his machine to the members of the Club at one of their meetings. Carrot and pith had been used for some time in cutting sections of vegetable tissues.

Dr. Hoggan said he should be most happy to bring his machine for the inspection of the members at the next meeting.

Announcements of meetings, &c., for the ensuing month having been made, the proceedings terminated by a *conversazione*, at which the following objects were exhibited:—

A Section Cutting Machine	By Mr. Bailey.
Ultimate Fibres of Crystalline Lens	Mr. T. J. Baker.
New Diatoms from South Seas	Mr. Curties.
Pleurosigma formosum	Mr. Goodinge.
Hydra Vulgaris (alive)	Mr. Hainworth.
Larva of Gnat	,, ,,
Section of Hazel Nut	Mr. F. Reeve.
Section of Human Brain (cut through cerebellum)	Mr. Slade.
Ruby Copper	Mr. Topping.
Transverse Section of Hair of Elephant ...	Mr. Underwood.
Agalasphœria Pluma	,, ,,
Parasite of Opossum	Mr. Watkins.
Injected Section of Kidney of Guinea Pig ...	Mr. T. C. White.
Eye of Dytiscus	Mr. G. Williams.

Attendance—Members, 102; Visitors, 23.—Total, 125.

April 10th, 1874.—Conversational Meeting.

The following objects were exhibited : —

Ixodes of Boa Constrictor	Mr. Curties.
Jaws and teeth of Echinus (polar)	Mr. Freeman.
Platino-cyanide of Magnesium	Mr. Golding.
"False-light excluder" for Objectives	Mr. Ingpen.
Elaters and Spores of Jungermannia (in glycerine)	Mr. Oxley.
Spicules of Gorgonia	Mr. B. W. Priest.
Ætea anguinaria	Mr. Terry.
Section of foot of Salamander	Mr. Topping.
Section of Lamprey (injected) *(Petromyzon fluviatile)*	Mr. Ward.
Marine life in small tank	Mr T. C. White.
Drop from Composite Candle (polar)	Mr. G. Williams.

Attendance—Members, 57 ; visitors, 6.

On the Preparation of Microscopic Sections of Soft Tissues.

By E. Tulley Newton, F.G.S.

(*Read March 27th*, 1874.)

Abstract.

The methods of cutting microscopic sections of soft tissues, and the different kinds of machines used for this purpose, have been for some time past subjects of interesting conversation among the members of the Club; and it was thought that an evening might be profitably devoted to the consideration of these matters. At the request of several members, Mr. Newton read the paper of which the following is an abstract:—

The author took occasion at the outset to observe that the object of the paper was not to bring forward anything new, but simply to open the discussion by calling attention to some of the methods generally used for the purpose of hardening, staining, and cutting sections of various tissues, and by describing a few of the different kinds of section-cutting machines.

The process of hardening tissues was first considered, and some of the advantages which were to be derived from the use of methylated spirit, solutions of chromic acid, and of bichromate of potash of various strengths were alluded to. Considerable stress was laid upon the importance of having tissues properly hardened, more especially when thin sections were to be cut.

The process of hardening nerve tissues requiring somewhat more care than most other substances, the method described by Dr. Rutherford was referred to ("Quart. Micro. Journal," Jan., 1872), and also that used by Prof. W. Betz ("Schultze's Archiv.," 1872, p. 36; translation in "Quart. Micro. Journ.," 1873, p. 343).

One or two methods of preparing sections of *Retinas* were noticed. (See Dr. Rutherford, "Quart. Micro. Journ.," Jan., 1872, and Dr. Klein, "Handbook for the Physiological Laboratory," 1873, p. 140).

Attention was called to the method of imbedding objects so that they may be more firmly held when sections are to be cut, and the various mixtures of white wax and oil, paraffin-wax, and lard, &c., were mentioned. The degree of hardness of the imbedding substance was stated to be of some importance, particularly when a machine is used, for if the wax be too hard the edge of the razor (which must always be very thin for delicate work) will have a tendency to glide over the top instead of cutting into the wax.

It is sometimes found convenient to imbed objects in *gum*, and to do this the tissue should be soaked in a thick solution of gum arabic, and then placed in a paper tray with some of the gum solution ; the tray is then allowed to stand in a vessel containing spirits of wine until the gum becomes hard enough to be cut with a razor.

Some objects may be placed between pieces of fresh carrot and then cut ; and in those cases where it is is applicable, this is an admirable material for the purpose, as it cuts very easily, and is at the same time firm and tough.

When speaking of the "cutting instruments" used for preparing sections, the author gave it as his opinion, that although ordinary razors answered very well when sections were being cut by hand, yet when one of those machines was used in which the knife has to move upon a flat plate, the ordinary form of razor did not answer, for it was found that the curved edge had a tendency to cut the edges of the aperture in which the object was held, and in this way the cutting edge was spoiled. The form of knife advocated was one which had the cutting edge quite straight and parallel with the back, the latter being thick ; both sides of the knife should be hollowed. The length and width of the blade should be in some measure proportionate to the size of the section to be cut. Whatever the form of the knife, it is absolutely necessary for the preparation of thin sections of soft tissues that its cutting edge be very sharp and thin

With regard to the staining of preparations, Beale's Carmine Solution was mentioned as being most generally useful for ordinary tissues. Nerve tissues require longer immersion in the staining fluid, and very good results were said to have been obtained by using a strong ammoniacal solution of carmine. (See "Quart. Micro. Journal," 1872, p. 10). It sometimes happens, more especially with sections of nerve tissues, that in the process of washing

after the removal of the sections from the staining fluid, too much of the colour is lost; when this is the case, a proportion of spirit should be added to the water used for washing.

The method usually adopted for mounting histological preparations in Canada balsam was described.

When describing the various "section-cutting machines" which had been kindly lent for the evening by several gentlemen of the Club, Mr. Newton observed that although some competent histologists had gone so far as to say that section-cutting machines were only used to make up for want of skill in the operator, he was of opinion that a properly-constructed machine would be found to be a very great advantage by most persons engaged in histological work; and, while admitting that very much might be done by hand with an ordinary razor, he felt sure that in many cases much more satisfactory work could be accomplished with the help of a machine.

Most persons who have tried the cutting of microscopic sections of a piece of tissue imbedded in wax, will have found that it is no easy matter to obtain a section of uniform thickness, and at the same time sufficiently thin for examination with the higher powers of the microscope.

The object of a section machine is to hold firmly the substance which is to be cut, and likewise to assist in guiding the knife so that greater precision may be obtained. Cutting machines are of two distinct kinds. 1st, those in which the knife has to move upon a flat plate, and 2nd, those in which the knife is so fixed that its cutting edge does not come in contact with anything but the substance which is to be cut.

1st.—Machines in which the Cutting Instrument moves upon a Flat Plate.

The first machine mentioned consisted of a brass tube fixed into a hole in the centre of a flat brass plate, a solid plug being fitted into the tube from below. The object from which sections are to be cut is imbedded in wax, or tightly fitted into the tube in some other suitable manner; by giving the plug a twisting motion, it is thrust into the tube, and the object made to project above the flat plate; a razor with a straight edge is laid upon the flat plate, and the portion of the wax with the imbedded object which projects above the plate is cut off. This simple apparatus was described so

as to illustrate the principle upon which most of the section-cutting machines used in this country are constructed.

In the machine described in "Science Gossip,"* the plug is raised by means of a graduated wedge which passes beneath it, the whole apparatus being fixed to a wooden stand, so that it may rest upon the table. This machine being largely composed of wood, would be liable to get out of order when wet with the spirit or water used in cutting sections.

The machine which is generally known as "Topping's," was next described; in this the plug is raised by means of a screw with a graduated head, so that the thickness of the object made to project above the plate may be easily regulated. There is another addition which this machine possesses which should be noticed, as it has been neglected in some of the forms which have been more recently in use for histological work, viz., a screw at one side of the tube, by means of which the object to be cut may be firmly held or compressed.

Machines of this construction are sometimes attached to a strong clamp, so that they may be fixed upon the edge of a table, thus leaving both the hands of the operator at liberty for manipulation.

"Stirling's Section Machine" was noticed as being one made specially for histological work. In this form the aperture for holding the object is larger than in those previously mentioned. The top plate with the tube and clamp are cast in one piece, thus giving considerable firmness to the apparatus. The author remarked, that in the machines of this construction, which he had had an opportunity of seeing, the screw for raising the plug was not sufficiently fine, or adjusted with the requisite care, to make the apparatus satisfactory for fine work. These machines do not possess a side screw for compressing the object.

Dr. Rutherford's addition to Stirling's machine consists of a trough placed around the tube; by filling this with pounded ice and salt, the object placed in the tube may be frozen, and in this manner made sufficiently hard for cutting into sections. This process of freezing is described in the "Journal of Anatomy and Physiology," 1871, p. 324.

Quite recently a form of section machine has been manufactured which is really a combination of Topping's and Stirling's, with certain modifications and improvements. The author described

* *Vide Science Gossip*, Aug. 1872, and June, 1873.

somewhat minutely the construction of this machine, an account of which will be found in the "Quarterly Journal of Science" for January, 1874, p. 128. This machine may be obtained with the top plate made either of *brass*, *iron*, *glass*, or *plated with nickel*, each of these substances having been proposed by different persons as the most suitable for the knife to work upon.

The machine which the author has been in the habit of using is constructed upon the same general plan as Stirling's; but it has a side screw for compressing the object, and the screw for raising the plug is firmly and carefully adjusted, and the head graduated so as to indicate a rise of the plug of $\frac{1}{1000}$ of an inch.

A machine made by F. H. Ward, Esq., M.R.C.S., and exhibited at the meeting, was of very similar construction to the author's; but was provided with a freezing trough and a glass top plate; in addition to this there was an arrangement by which the central aperture could be reduced in size to accommodate smaller objects and the graduation of the head of the screw was arranged on an improved principle.

2ND.—MACHINES IN WHICH THE EDGE OF THE CUTTING INSTRUMENT DOES NOT COME IN CONTACT WITH ANYTHING BUT THE OBJECT TO BE CUT.

Two machines of this description were noticed; the first of these was of German construction, and consisted of a plate of metal about 8 inches long, $2\frac{1}{2}$ inches wide at one end, and 3 inches wide at the other, and about $\frac{1}{4}$ of an inch thick; this was fixed by one of its longest edges to the middle of another plate of metal which formed the base for the whole apparatus. Upon each side of the upright plate there was a kind of ledge or shelf; one of these was parallel with the base, while that upon the opposite side was parallel with the top edge of the upright plate, and consequently formed an angle with the base. Upon the horizontal ledge a block of metal was fitted so as to be able to be moved backwards and forwards; to the top of this block a razor-like knife was attached. The oblique ledge was fitted with a similar movable block, and upon this was a contrivance for holding a piece of wax containing the object to be cut. By this arrangement the razor remained at the same level when the block to which it was attached, was moved from one end of the horizontal shelf to the other, while the object was gradually raised when the block to which it was

fixed was pushed up the inclined shelf. Supposing the razor to have taken a slice off the wax and object when the holder was at the lower end of the inclined shelf, then as the holder was pushed up the incline, successive slices could be cut off. The top edge of the upright plate was graduated so as to regulate the thickness of the sections.

The last machine referred to was the one which is described in the January number of the "American Naturalist" for the present year, and is the invention of Prof. T. D. Biscoe. In this apparatus the object to be cut is fixed by appropriate means to the centre of a flat piece of glass. The razor is firmly screwed to the under side of an open triangular frame, through each corner of which a fine screw passes. The lower ends of the three screws rest upon the glass plate, and consequently by turning the screws the triangle and the razor may be gradually brought nearer to the brass plate, and the operator is thus enabled to remove successive sections of the object. The great advantage in this machine is that the razor and its support can be moved in any direction, and if desired, sections can be cut under the microscope.

In concluding, Mr. Newton observed that a section-cutting machine, in order to be trustworthy, should possess the following qualifications, viz.:—

1st.—It should be *firm* in all its parts, made of good solid material, so that there may be no bending or shaking when in use.

2nd.—It should possess a clamp, or some other arrangement, by which it may be firmly fixed, so as to leave both the hands of the operator free for manipulation.

3rd.—The top plate upon which the knife rests should be perfectly flat, otherwise the knife will "rock," and prevent that steadiness which is necessary when thin sections are required.

4th.—The regulating screw should work very truly and firmly, for if this is not the case the sections will vary in thickness.

5th.—The cutting instrument, whatever its form, must have a thin and very keen edge.

After the long discussion which followed the reading of this paper, the author demonstrated the use of the section machine by cutting a number of sections of spinal cord for distribution among the members of the Club.

How to Make Thin Cover Glass.

By G. J. Burch, Esq.

(Read April 24th, 1874.)

Take a piece of glass tube of about $\frac{1}{4}$in. bore, seal up the end with the blow-pipe, and continue the heat until the glass is so soft that it will fall out of shape, unless you keep turning it round; *remove it from the flame*, and blow into it with all your strength. It will be seen to swell, at first slowly, and then suddenly to a large bubble of very thin glass. Supposing the tube to have been sealed up with as little glass as possible, it may be blown out to about 4 inches diameter. When cold, break it up, and cut the pieces to shape with a "writing diamond." The glass in this state is of course convexo-concave; practically this is of little consequence unless the objects are to be mounted dry, when it is liable to be broken. In order to flatten it, place a piece of the thin glass on a perfectly flat piece of platinum foil, and depress it for a moment into the Bunsen flame; as soon as it is red hot, it will sink down to the flat foil. This also has the effect of annealing it.

On measuring a piece of this glass with the micrometer, I found it to be $= \frac{1}{2500}$ inch $= \cdot 0004$ inch.

In the "Monthly Microscopical Journal," vol. viii., page 270, Dr. Royston Pigott says:—"The thinnest glass in my possession measures $2\frac{1}{5}$ thousandths." Now $2\frac{1}{5}$ thousandths $= \cdot 0022$, and $\frac{\cdot 0022}{\cdot 0004} = 5 \cdot 5$. So that his thinnest glass is $5\frac{1}{2}$ times the thickness of mine.

I enclose a small piece, the thickness of which is about ·0004 in., *perhaps less.* I do not advise anyone to make all his covers this way, but only the very thinnest.

On a "False-Light Excluder" for Objectives.

By John E. Ingpen.

(Read April 24th, 1874.)

I wish to bring before your notice this evening a simple method of getting rid of the glare frequently present even in the best objectives. When I tell you that it is nothing but a cap having a small aperture, and capable of being slipped over the objective, you will probably consider it a very insignificant affair ; but the principle involved is an important one, and well worthy of a few minutes' attention.

In the "Monthly Microscopical Journal" for March last, p. 112, there is a letter by Mr. Wenham, in which he explains his method of measuring the angle of a Tolles' $\frac{1}{6}$-objective belonging to Mr. Crisp. The principle of this method is that the rays which constitute the true working aperture must be "image-forming rays "only." Mr. Wenham contrives to admit only those rays which can enter an aperture the size of the field of view, and in the plane of the object ; and he shows how false light may enter an objective outside the field of view, and at a much greater angle than any rays which could possibly form an image of the object; and he proves that the true working angle of the Tolles' $\frac{1}{6}$ cannot be greater than 118°, while stray light can enter the front lens almost up to 180°.

Upon reading the above letter, it struck me that the method by which false light was excluded in measuring the angle would equally well serve to keep out false light in using the objective, and thereby improve the definition. I had not to go far to apply it. A fine Ross $\frac{1}{4}$ of 100°, with which I constantly worked, always shewed a blaze in the centre of the field when direct light was used, while with oblique light its resolving power was excellent. I soon had a cap made with an aperture a little larger than the field of view with the lowest eye-piece; when this cap was slipped on to the objective, and brought down so as to touch the covering-glass, all the false light vanished, the milky appearance of diatoms so often seen when viewed with large angled glasses was replaced by a clear black definition, while the angle was scarcely diminished,

and the resolving power in no way injured. When the cap was slipped up close to the objective the angle was reduced from 100° to 70°, with far finer definition than when limited to the same angle by a stop at the back. So completely is the stray light stopped out that in many cases the diaphragm may be dispensed with.

The nearest approach to the kind of definition above mentioned was obtained by the Continental method of using a very small aperture as close under the object as possible, instead of a larger one lower down, as is usual in this country; and this method might often be used with advantage where a cap could not be placed over the objective. This method, in its best form, was first proposed by Mr. Varley many years ago, and called by him a "dark "chamber." Though long since forgotten and disused, it might be well worthy of re-introduction now that quality of illumination is considered to be a matter of primary importance.

On the Development of *Hydra Vulgaris*.

By James Fullagar, Esq., Assistant Secretary, East Kent Natural History Society, Canterbury.

Communicated by Mr. Curties.

Read April 24th, 1874.

It appears from the statements of various writers on Natural History, that the development of *Hydra* from ova has never, or very rarely been witnessed, though, at the same time, no doubt is entertained of the *fact* that one of the means of its reproduction is from ova. I have had *H. vulgaris* and *H. viridis** under my observation for more than three years past, and, after various failures and disappointments, I have at length succeeded in witnessing the hatching out of several specimens of *Hydra vulgaris*, an account of which will, I hope, be interesting to the Quekett Microscopical Club.

Hydra vulgaris differs in many respects from *Hydra viridis*. The egg is larger, and studded with what appear to be short spines (pl. xii., fig. 1, *b*). The shell is not smooth, nor is it covered with an irregular network, as in *H. viridis*, but it is surrounded with a transparent gelatinous envelope, which it retains to the time of

* A paper on the Development of *Hydra Viridis* from Ova will be found in "Science Gossip" for 1873, pp. 12 and 175.

hatching. The egg of *H. viridis* has at first also an envelope, which disappears some time before hatching. In fig. 1, *c.*, I have particularly marked the triangular-shaped darker spots in the envelope; they appeared as regular as in the sketch, a little denser than the rest of the envelope, and surrounding the whole of the egg. This, however, can only be seen at the margin, but on moving the egg in the water, it may be seen on every part, and always presenting the same appearance. The diameter of the egg of *H. vulgaris* is $\frac{1}{50}$ of an inch, that of *H. viridis* $\frac{1}{66}$ of an inch.

On October 27th, 1873, I placed in a glass cell a specimen of *H. vulgaris*, on which an ovum had begun to form. It was put into pure clean water by itself, so that nothing obstructed the view, and the changes which took place from time to time were very clearly observed. Besides the ovum, it had three fully-developed sperm cells (pl. xiii., fig. 7, *K.*), in which spermatozoa were seen in active motion, and from each of which, at intervals, a quantity was discharged into the surrounding water (fig. 7, *L*).*

On October 30, the egg (fig. 7 *M*) became detached from the *Hydra*, and sunk to the bottom of the cell; it then presented the appearance of fig. 1. It was at first of a cream colour, which soon changed to orange. It should be noticed that the gelatinous envelope frequently becomes covered with extraneous matter, through which the egg cannot easily be seen; this may account for the difficulty of obtaining the ova from ponds and ditches, as they are so well concealed from observation. The collection of substances around the eggs, acts, I believe, as a protection from pressure, for on leaving the *Hydra*, they are very soft, and easily crushed. I have seen small *Cypris* burst them at an early period; but they soon become hardened so as to resist pressure, and can then be removed with a dipping-tube for observation.

The ovum is at first globular, but if it falls in its soft state on a flat hard substance, the underside becomes flattened, making it hemispherical or helmet-shaped; this does not hinder its proper development.

As the time for hatching approaches, the envelope surrounding the egg becomes irregular (fig. 2 *D*), and the egg is slightly pushed out on one side (fig. 2 *E*). In the specimen above mentioned this

* The spermatozoa were originally made out by Mr. Gulliver, F.R.S., who obtained specimens of the Hydra from me, and executed drawings of the spermatozoa, which are engraved in "Science Gossip," vol. for 1873, pages 13 and 41, and are the first representation published of these objects in this country, if not in the world. My own objectives were not of sufficient power for such delicate investigations, but Mr. Gulliver, with Powell and Lealands' $\frac{1}{16}$, was well prepared.

change was observed on January 24th, fifty-five days after extrusion; in a few minutes a slight crack was seen in the shell, and a portion of the young *Hydra* slowly emerged from it, in a rounded form, as shown in fig. 3 *F*, sketched two hours after the first perceptible crack in the egg. It continued slowly emerging, and in two hours afterwards rudiments of tentacles appeared, as rounded lumps (fig. 4 *G*). Seven hours after the first rupture of the egg, the tentacles had progressed to the condition shown in fig. 5 *H*, and in twelve hours the *Hydra* was fully developed, with seven tentacles, and in all particulars like the adult, size only excepted. Its appearance was most interesting—delicately pure, and beautifully transparent, as if made of crystal, and still attached to the inside of the shell by the suctorial disc at the posterior end of the body (fig. 6 *I*). Some specimens finally leave the shell about twelve hours after being fully developed, others twenty-four, or even sixty hours afterwards, when they fix themselves to the bottom or sides of the cell. Their growth is very slow, and I could not discover what they took as food. After a month had elapsed, I introduced some small entomostraca, but though they seized them with their tentacles, they could not absorb them. The entomostraca died, however, from the effect of the stinging power of the tentacles. The young have not all the same number of tentacles; one observed had five, most had six, and some few had seven.

After the extrusion of the ovum, the parent *Hydra* gradually diminished, the tentacles shortened and slowly disappeared, and in about twenty-one days the whole body dissolved. The sperm cells, three in number, continued on the body for some days after the ovum had been separated from it, and continued to discharge spermatozoa into the water.

Both ovisac and sperm-cells are usually found on the same *Hydra*; but sometimes sperm-cells only are found, when the whole length of the body is studded with them. I have counted in some cases eleven, in others seventeen, and in one as many as twenty-three but where an ovum is formed the sperm-cells rarely exceed four in number.

The reproduction of *Hydra vulgaris* from ova takes place in the autumn, and that of *Hydra viridis* in the spring.

DESCRIPTION OF PLATES XII.—XIII.

Pl. xii.

Fig. 1. Ovum of *Hydra vulgaris*. *a*, transparent envelope, *b*, short spines *c*, triangular shape markings on envelope.

Fig. 2. *D*, appearance of envelope before the rupture of the egg indicated at *E*.
„ 3. *F*, part of the *Hydra* protruding from the egg.
„ 4. *G*, indication of tentacles.
„ 5. *H*, further development of tentacles.

Pl. xiii.

Fig. 6. Full development of young *Hydra*, fixed to the inside of shell at *I*.
" 7. *Hydra*, *K*, sperm cells, of which there are three; *L*, discharge of spermatozoa; *M*, ovum about to leave the body.

On a new form of Section-cutting Machine for the Microscope.

By George Hoggan, Esq., M.B. and C.M.

(*Read May 22nd*, 1874.)

Having been requested by your President to exhibit the Section-cutter invented by me, and to show the manner of making sections of hard and soft material by it to your Society, I willingly comply, not with the idea of showing you anything very ingenious, but simply as a means of facilitating histological research; and at the present day I know none of its departments in which more valuable aid can be rendered than in the contriving of some plan whereby large sections of different materials may be cut easily, quickly, and correctly. These three words embody the design aimed at in this machine, and they ought to form the three heads of any discourse on section-cutting.

At the same time I shall not confine myself to a mere description of my machine, but give also such hints as may prove useful in section-cutting generally, hints which I myself have discovered and proved by long experience; but although the inventor of a section-cutter of an entirely new design, I must warn you against the supposition that section-cutting is the only thing needful in histology; on the contrary, most of the histology of isolated structures may be investigated by teazing with needles or by cutting small pieces by hand, but when the general relation of histological elements in any organ, or the origin of morbid elements (as in a tumour), is to be investigated, then it is only by a complete section of the whole mass that a correct idea can be arrived at.

To effect the section of such large masses I insist on the

necessity (of what may be called the heretical doctrine) of cutting by means of a series of short cuts, in contradistinction to the method of cutting a section by one sweep of the knife so continually insisted upon; apparently because none of the section-cutters now in use are capable of effecting the method of short cuts; for that method requires that the mass to be cut be firmly grasped or compressed in the machine, so that it (the mass) may be prevented from rising out of the machine against the knife, or yielding in any way whatever at each separate cut or change of direction, thus preventing lines or marks of each separate cut on the finished section; and it is for cutting sections of large masses of unequal consistence that my machine is particularly adapted.

Those among you who pursue Medicine on scientific principles will at once perceive the value of such a machine in pathological histology, more especially when I quote the opinion of one known by most of you as one of the first and best workers in histology, my friend Dr. Ranvier of the Collège de France, who says that the histology of tumours can now only be advanced by the examination of sections of the whole tumour, a thing hitherto practically impossible, but now put within reach of everyone by the introduction of this machine.

The desirability of directing attention to section-cutting must be apparent to everyone who gives his consideration to works on original research, where the formation or ventilation of theories is carried on; for it will have been observed that, when any author seeks to uphold a theory of his own, or destroy that of another, he never questions the powers of the microscope, but rather the respective value of the preparations themselves; and so much skill is required to make good preparations, that very few ever arrive at it; yet strangely enough, although men are willing to expend large sums in purchasing and perfecting expensive microscopes, few are extravagant enough to go beyond buying an old razor, or at best a double-bladed Valentine's knife, for the purpose of preparing the sections they wish to examine, thus giving more importance to the means of observation than to the preparation of the thing to be observed. Yet were they to take into consideration the great saving of time, the obviating of any necessity for skill, with the beauty and correctness of sections, that can be effected by the use of a good section cutter, they would, I have no doubt, be inclined to direct more attention to the latter.

Unfortunately, the histological mind appears to have got into a groove with regard to the section-cutters, from which it seems helpless to extricate itself; for proof of this one has only to look at the tube section-cutter and the hundred and one modifications and names which it bears. Thus we have Topping's, Beale's, Stirling's, Ranvier's, Rutherford's, all very good in their own way, and a host of others too numerous to name here. The name of the original inventor of this good and simple little machine seems to have been long lost,* though Ranvier tells me (he himself laying no claim to the invention) that above thirty years ago it was in use in some German laboratories; now-a-days, however, anyone desirous of obtaining a name in histology has only to add a screw here, or a plate there, or take away the same, and henceforth the machine is called by his name, and the histological laity who examine the parts of the completed machine, gape in wonder at the ingenuity of the individual whose name it bears.

Luckily for me I had never seen one of them when I commenced the construction of my machine, and it is probably to that fact that I owe the conception of a machine differing in all its parts, movements, and action, from any other. At the same time do not suppose that the finished machine now exhibited is similar in its parts to the one I at first constructed—the design is certainly the same, but I have added many improvements, and failed in ten times more supposed improvements, which have therefore been discarded, but which will probably be again brought forward by a future host of plagiarists who will add a screw here, and a pin there, to the general detriment of the machine, and will thenceforth call my child by their name. Yet with that future clearly before me, I give forth my invention freely to the world, without patent or any hindrance whatever, either to earnest worker or imitator.

As the machine now exists, it may appear to most of you as being too complex, at least when compared with most of the section-cutters now in use; and those people who believe in the common-place idea that the more complex a machine is, the less useful it

* "The first instrument of this kind was invented by Adams, about the year 1770, and was subsequently improved by Mr. Cumming; it is described and figured in the microscopical essays of the younger Adams * * * * A very excellent machine for this purpose, which the author has been in the habit of using for *many* years * * is shown in fig. 254. * * Mr. Topping has contrived a very convenient and useful form." * * * —*Quekett on the Microscope*, 3rd Ed., 1855, p. 359.—Ed. Q. M. J.

will be, may even consider such complexity a great objection to it; but this idea can only be entertained by those who are ignorant of the advantages which machinery has over the more primitive modes of working. Thus, for example, a hammer and chisel are more simple and less complex than a planing machine, both being used for the same purpose, yet with what different results! Yet fifty years ago the chisel did what the machine now does, and with results that throw all comparison in the shade, and I could institute a similar comparison between the present accepted methods of making sections (especially hard ones) and that performed by the aid of the machine. In the meantime I wish you to understand that the various apparently complex parts were added to an originally simple contrivance as the necessity for them made itself manifest, in order to enable sections to be cut more easily, more quickly, and correctly. In short, wherever I found that any exercise of skill on the part of the operator could be dispensed with by adding some contrivance to the machine for that purpose, I never scrupled to make the addition; consequently, the more complex the machine became, the less necessary was the possession of skill to the operator; and, indeed, I know of no better way of explaining the different pieces and method of working the machine, as well as to prove the complete originality of the whole design, than by giving a history in detail of the construction of the first machine, which I have brought here to-night for that purpose. The various desiderata will probably occur to you as they presented themselves to me, and you will be able to form your own opinion of the manner in which I have satisfied them.

Originally I intended to construct an apparatus for cutting sections of hard material only, such as bone, teeth, etc., and I commenced the task in my bedroom, with a few scraps of brass-plate and nails that I found lying about the house, without any intention of going beyond the very simplest possible arrangement of at most two or three pieces; the rest of the parts were added as the necessity for doing so showed itself, and I ask you to keep this in mind as you examine the grotesque construction of those parts—they were contrived to suit the bits of brass I possessed; in short, this my coat, was cut according to my cloth.

At first I only intended to make a brass frame, against which I might press the saw or knife, so as to enable me to cut steadily. Finding, however, that it was very difficult to hold the frame

steady, as well as the article to be cut, with the fingers of my felt hand, while I used the saw with my right, I considered it advisable to screw the frame upon a portable table or block of wood, so that I now only required to hold the article to be cut with the fingers of my left hand, while I cut with my right. My next step was to contrive an arrangement which would fix the article to be cut on the table; this completely relieved the fingers of my left hand, but it had still the inconvenience of requiring to be unfixed and carefully refixed in the plane of the preceding cut at every section, in order that it might be of equal thickness throughout. I therefore contrived to fix it on a metal table, moving at right angles to the track of the saw, and in order to obviate any awkward jerking or unequal movement, I gave it motion by a screw, which enabled me to move it correctly to the $\frac{1}{500}$th part of an inch, and to tell the thickness of the section at the same time.

I next experienced inconvenience from the saw cutting into the brass frame, so that it was necessary to form a facing of hardened steel, and as I found that unless great care was used the saw was apt to cut awry, I placed a similar steel facing as a guide on the outer side of the saw, which now moved in a thin slit of hardened steel, from which it could not deviate. To make the path of the saw quite correct, I filed out from the upper part of the machine as much metal as was equal to half the thickness of the saw frame, so that the centre lines of both saw and saw frame moved in the same perpendicular plane; and to complete matters, I added guides for the outer side of the saw frame itself, so that sections of hard materials could now be made without the exercise of any skill whatever.

From this history of its construction you will be able to understand the general design of the machine, and I may, therefore, sum up its description in a few words.

In plate xiii., fig. 1, is a side view of my section machine as arranged for cutting sections of hard substances, fig. 2 being an end view of the same, and shewing the saw in position. Figs. 3, 4, and 5 shew the machine as arranged for cutting sections of soft substances, fig. 3 being a longitudinal vertical section, fig. 4 a view of the opposite end of the machine to that shewn in fig. 2, and fig. 5 a sectional plan.

It will be seen that the machine consists essentially *of a metal table* (A) *moved steadily backwards and forwards by a graduated*

screw (B). *Upon this table the hard material is firmly fixed by a screw clamp* (C); *a fine saw* (D), *firmly guided by the supports* (E), *and springs* (F) *makes the first cut. The table* (A) *is then moved forward the requisite distance by means of the screw* (B), *the saw again put in action, and a section is made equally thin throughout, and ready for examination by the microscope.*

You will now also understand why my machine differs from all others, I having started originally from a very simple idea, and only made additions as the apparent necessity arose, and the result was, that the more complex it became, the less necessity was there for skill, and the greater the saving of time and labour to the operator. There are still several points to which I must call your attention, connected as they are with the careful working of the machine under different circumstances and on different materials. Of these I shall take muscle and brain matter as representing soft material, and bone and teeth as representing hard material. For these two different consistencies the two opposite sides of the machine have been separately adapted, and I shall commence with the latter, *i.e.*, the hard substance—anything, in fact, which steel will cut. Take for example a tooth (not the enamel part).

Now, if we consult the latest works on histology, say those of Beale and Kölliker, we are informed that to prepare a section of a tooth, we first break off a piece as small as is convenient, and fix it by means of some hard cement, which will hold it firmly embedded while one side is being ground down perfectly level and polished on a lapidary's wheel. This finished side is next to be placed, in its turn, upon a piece of plate-glass, by means of cement, and the other side is then ground down until the remainder is so thin as to be transparent and polished; it is then to be taken off, cleaned, and mounted, and I leave you to consider the time, the skill, and the labour required to make one section according to that formula.

Now, with my machine, you simply lay the tooth on the brass table under the saw, tighten it down, place the saw in position, and work it backwards and forwards till the first cut is made; all this may occupy five minutes. After this you may make a dozen sections, occupying two or three minutes with each section; these come off polished and clean, and ready for mounting. Moreover, no practice or skill is required; any tyro can make a good section on at most his second attempt, for neither saw nor article sawn can

move from the correct position, and the saw cut which cuts off one section forms the parallel plane for the next.

Let us now take the case of bone sections. The same authors advise us to take a bone and saw a bit off it in the ordinary way; this may average $\frac{1}{8}$ of an inch thick. We are then to file it down as thin as possible without breaking it (this will probably stiffen our fingers); it is next to be rubbed down on an oilstone, and should the pulp of our fingers give way under this operation we must use two oilstones, between which the bone is placed, while the two stones are rubbed against each other. (In the Collège de France two pieces of pumice stone are used for the same purpose.) You may thus, perhaps, succeed without any breakage in making a section after two or three hours' labour, which is ready for mounting, and it will look very well indeed, as far as the sharp definition of light and shade is concerned, for every lacuna and Haversian canal is filled up with the black dirt or debris of the oilstone, giving a sharp enough outline certainly, but not on that account a true idea of the bone substance which you wish to examine.

With my machine a piece of bone, say $\frac{1}{2}$ inch square and of any length, is placed on the table in the same way as in the case of the tooth, and you may then proceed to make sections, which may each occupy five minutes at most in cutting, and they are then ready for mounting. The sections I now show you, about $\frac{1}{2}$ inch square, were made from the head of the Tibia, while a friend stood by and noted with his watch the time taken to cut each, while I made a dozen sections, and we found that each occupied from $2\frac{1}{2}$ to 3 minutes, the dozen being completed within 40 minutes. The saw-dust was then washed off, and they were mounted without further preparation, and I leave you to institute a comparison between these and the old processes.

In sawing, however, I wish to draw your attention to a most important point—namely, to have the teeth of the saw directed towards yourself, and to saw when drawing back, not when pushing forward. I cannot well conceive a more vicious and unmechanical mode of using a saw than that generally practised by Europeans, in having the saw-teeth directed from the workman and sawing as it is pushed from him, working thus in the worst possible position for the application of both power and precision.

In my younger days I was sent to learn carpentry, and I still remember, with a shudder, the aching arms, the deviating saw

track, and the fruitless jerking, bending, and quivering of the saw-blade, as the teeth bit too deep, and rendered it necessary to dislodge them before any further progress could be made.

Then, again, think of the clumsy contrivances rendered necessary in consequence of this vicious custom, the strong backs necessary for tendon and surgical saws, some of these fitted with joints so that the operation of sawing may not be stopped when the back reaches the edge of the sawslit. Think also of the torture of sawing in the dissecting-room (both to the person who saws and to the person who looks on), of the dangerous wounds caused, the sweating, the jerking, and locking of the sawblade; of the bent blade and broken saw-teeth that inevitably result from this bad principle; and you may then be able to conceive how much trouble may be avoided by simply reversing the position and action of the saw-teeth. In this matter the Arabs are far ahead of us. When in Arabia I noticed a native workman using a saw like an old barrel-hoop in a most efficient manner on some rather ticklish timber. On looking at it minutely I observed the reversed direction of the teeth, and at once perceived the value of the arrangement.

It must be evident to you all that power can be better applied in drawing back than pushing from one; hence it is that beginners generally get over any difficulty by sawing as they withdraw, thus breaking off or blunting the saw-teeth. Again, with the teeth reversed, no back is needed to the saw, for should the teeth bite too deep the greater the strain applied the more tensely straight the blade is held.

Moreover, an unskilled arm can use more precision in drawing back than in pushing forward, and thus this method of using a saw will be found to be superior in every way to the present method; and I hope soon to see it supersede it, more especially in Surgery and Anatomy. In my dissecting-rooms in Edinburgh all my pupils used, with the greatest facility and precision, an unbacked saw thus prepared, without a single wound having been received, and the saw itself was in as good a condition at the end as it was at the beginning of the session.

I think it unnecessary to apologise to you for this apparent digression, the point being of the greatest importance in the working of the saw in my machine; for without this explanation the utility and advantage of thus using the saw might have

failed in convincing you, or at all events in impressing upon you the necessity of so using it.

As connected with the sawing side of the machine I may note that the saw called the "Pearl saw" is the best adapted for the machine. This I have found, as the result of experience, after having tried about a score of different sorts and sizes, some of them much larger and coarser, while others were only about one quarter the size of this one. The larger saws, however, left too coarse a surface on the section, and were very apt to break down thin sections; while the very fine saws were apt to bend, and thus go out of the parallel plane. As a rule, choose those with the finest teeth, the thinest blade, and as broad as possible—say about one-eighth of an inch broad. These blades only cost 6d. a bundle of one dozen, so that one need not be tempted to use a saw too long on account of its costliness. Put also a thin piece of cork or wood under the material to be cut; this prevents the saw from cutting the brass table, and it also keeps the article to be cut steadier while being sawn. A little bit of brown paper between the screw point and the article has a good effect in the same way.

Put also a little oil on the frame of the saw, so that it may work easily in the upper guides, but do not oil the saw-blade, or the section will be dirtied thereby. It will be seen that the bases of both upper and lower saw guides have a slit cut in them, and are tightened with a thumbscrew. This enables us to regulate the distance according to the thickness of the saw; and we are also enabled to remove them, when necessary, without altogether removing the thumbscrew. In addition, the upper ones have the upper edges of the base levelled, so as to fit into a corresponding levelled groove on the top of the frame, so that by keeping it firm in position all shaking when sawing may be avoided. The bases of the lower ones are similarly guided by the inside edge lying against the edge of the moving table, which projects above the level of the plate for this purpose.

The contrivance for fixing the article to be cut on the table consists of an arched piece of metal (c), through the centre of which the compressing screw passes, and having its extremities formed like the T headed bolts used in machine shops for bolting articles on to a moving table. These two extremities move in two parallel grooves along the table, and thus enable us to fix the article to be cut at any part of the table, and also to use two compressors at

the same time, should that be considered necessary. The action of fixing the article has also the effect of fixing the compressor itself firmly to the table. Should the table begin to wear or move loosely, it is easy to tighten it by a few taps of the hammer on the lower cross bar of the framework. Bear well in mind that there must be no shaking whatever permitted in any part of the machine while it is being used for cutting hard material with the saw. Observe also, that the screw (B) at its rear end is guarded on one side by a collar, and on the other side by a nut and washer or double jamb nut, so that any wearing may be easily rectified. I mention those points because at different times workmen have thought themselves justified in altering the plans on those very points, thinking that they substitute a better. But in every case the machine was injured, and the original plan had to be reverted to.

Let us now turn to the side of the machine for cutting sections of soft material, which has been added to the frame originally designed for cutting hard material only; and in the first place I may remark, that while hard sections are cut perpendicularly with the saw, soft sections are cut horizontally with a knife or razor, so that while being cut the section may float off on some liquid with which the blade of the knife has been lubricated. The machine consequently stands on its edge, but is fixed with a clamp by means of the slit cast in the iron sole plate or base, upon the table or bench where it is proposed to use it. This side then may be described as forming a cubical box, of which one side is wanting—that one on which the sections are cut. The moveable table, and the base or bottom of the box which is screwed upon it, form other two sides which are movable, and by means of these the material to be cut is fed or pushed upwards to the level of the free side, where the knife works in cutting; the right and left are other two sides formed by the framework of the machine, and are firmly fixed and parallel throughout. The sixth and last side is that one by which the mass is compressed, or the cavity of the box altered from $1\frac{1}{2}$ to $\frac{1}{2}$ an inch in depth.

This side (which has received from the workmen the name of the "tray") moves only in one direction at right angles to the course of the material to be cut, and has flanges cast on three sides to prevent it moving awry or obliquely, either from side to side or from above downwards. Moreover, the flange at the back or bottom, moving

as it does between the saw guides (which have been utilised as guides for it also) keeps the free edge always close up to the edge of the razor and immoveable in that position; the tray itself is easily moved backwards and forwards by the fingers, but the requisite heavy pressure is brought to bear upon it by a screw (G), fixed in a cross beam (H), which slides on to the top of the framework when required.

In cutting hard sections the bottom and moveable side, as well as the cross beam, may be removed and replaced in less than a minute, so as to impede in no way the working of the machine.

Now suppose we wish to cut a section of some soft material, it seldom happens that it fits exactly the cavity or box of the machine, and consequently some matrix is necessary to hold it firm, and for that purpose I have found nothing better than a piece of fresh hard carrot.

A cube of this vegetable is roughly shaped to the size of the box of the machine, then cut into two halves; a cavity roughly adapted to the size of the article to be cut is formed between the halves, and these, with the article between them, having been placed in the machine, are firmly compressed by screwing down the movable side upon them when it is ready, and firmly fixed for making sections; only one caution being necessary, namely, never to cut as far as the brass table, or the razor will be blunted at once. Therefore, under all circumstances, some carrot must intervene between the material to be cut and the brass table.

Now for a word as to the kind of knife best adapted for cutting sections. I myself always use a razor for that purpose, either with the edge quite straight or the lower surface quite flat, so that the section may be of equal thickness throughout; these precautions are highly necessary. In all cases the upper surface of the razor or knife is ground as hollow as possible (as it usually is), and it also ought to be as broad as possible, so that it may serve as a sort of reservoir to contain the liquid used in lubricating the razor. Upon the surface of this liquid all delicate sections are floated off while they are being cut, to prevent them from breaking up, collapsing, or being otherwise destroyed. I use various liquids for this purpose, such as glycerine, methylated spirit, turpentine, or oil of cloves, water, &c.; but the two best, that I have not hitherto made public, are: water, to which a little caustic soda or potash has been added, till it feels like oil, for some substances; and the

refuse alcohol, in which a gum preparation has been hardened, after which it acquires an oily consistency.

When the material to be cut is so very delicate that any undue pressure would destroy it, I make the cavity in the carrot much larger than the material to be cut, and fill up the superfluous space with bits of dry elder pith; these are carefully packed in between the carrot and the material, the movable side is then gently pressed, not screwed down; the pith is wetted with alcohol, which causes it to swell evenly in every direction, adapting itself to all the parts without unduly compressing them, and holding the material firmly, while it gives a steadying influence to the edge of the knife, and prevents it from slipping when an extremely thin section is being cut, a mishap that often occurs with carrot.

I use no other matrix than the two I have mentioned; the latter I found in use at the Collège de France, and it is extremely serviceable. Of course anyone having a predilection for wax or paraffin can use them in a hole made in the block of carrot, just as they would use the tube apparatus for that purpose; indeed, all the advantages of that apparatus are to be found in my machine, with all its own advantages superadded, none of which are possessed by the tube machine in any of its innumerable modifications.

The method of determining the thickness of sections to be cut is very simple. The feeding screw (B) has 25 threads to the inch, consequently each turn of the screw moves the table forward 1-25th of an inch. A 12-toothed wheel, on side I, is fixed on the end of the screw, and if this be turned round the distance of one tooth or space, that is 1-12th of a turn, then the table moves forward the 1-12th part of the 1-25th of an inch; or, in other words, the 1-300th of an inch, the thickness of such section if one was cut. One half of a space would give 24 times 25, equal to 600, and so on.

I may remark also that the cavity of the machine now before you, which is $1\frac{1}{2}$ inch cube, is made of the most convenient size for ordinary work; it will possibly occur to some of you that it might be made to cut much larger sections. This is quite true, though I do not advise it; but it is easy to enlarge it by the addition of three extra pieces adapted to the present machine, which shall cut any requisite size of section; indeed, within the last three weeks I have, with the assistance of my wife (who is no mean microscopist),

adapted those three pieces to the machine now before you, upon which she intends to cut sections 6-in. by 4-in. But as I cannot at present enter into a description of them without trespassing upon her privileges, the Society, for the present, must do without them.

I now conclude my paper on section cutting, and hope at some future time to describe the best methods and precautions used in hardening tissues to be afterwards cut. The question of hardening, like that of staining and mounting tissues, requires a separate paper for its consideration.

On the Histology of Plants.

By R. Braithwaite, M.D., F.L S., &c.,

V. Simple or Homogeneous Tissues.

(*Read May 22nd*, 1874.)

We may now pass to the consideration of the various tissues which enter into the structure of plants, by which we understand every combination of cells constituting the various organs which contribute to the common growth. By examination of the individual parts of which these are built up, we find they may be readily arranged in two groups:—1. *Homogeneous tissues*, composed of cells which are uniform or all of one kind, and including *Primary parenchyma*, *Pith*, *Cortical tissue*, *Cork tissue*, and *Cuticle*; 2. *Heterogeneous tissues*, in which there is a mixture of different kinds of cells, and embracing the *Vascular bundles* with their wood and bast parts, the *Cambium layer*, and the *Medullary rays*.

Homogeneous Tissues.

1.—Primary or Fundamental Parenchyma is the basis of all new growth, and therefore is found in the youngest parts before the cells have undergone differentiation. As it is constantly increasing by division, it has been named by Continental botanists *meristem*, and may always be seen in a thin section of the growing point of buds, and in the earliest stage of leaves. Young unexpanded buds of the fig-tree or horse-chestnut afford good examples, and taking sections at various distances from the point, the gradual stages of differentiation may be readily observed. The constituent cells are thin-walled and spheroidal, thus leaving intercellular spaces, and by application of sulphate of copper and liq. potassæ, the cell contents become well defined.

2.—PITH TISSUE may be considered as the first advance from the primary parenchyma, from which the cells differ but little in form, but become somewhat elongated, and acquire a secondary thickening of the cellulose case. The pith occupies the centre of the axial organs in the higher plants, and in monocotyledons and vascular cryptogams forms the intermediate tissue which separates the inner vascular bundles from each other.

Pith cells vary greatly in form, and thus various names have been given to the various kinds of pith tissue, as *incomplete parenchyma*, when the cells touch each other only at separate points, and according to the form of cell we have *rounded* parenchyma, as in the pith of peony, *spongy* in that of canna, and the middle of leaves, and *stellate* in the rush. In *complete parenchyma* the cells are closely in contact, so that intercellular spaces are absent, or if present narrow and triangular; one variety is the *regular* parenchyma, where the three diameters are nearly equal, and this by the shortening of one of them becomes the *muriform* tissue, while *elongated* parenchyma is more particularly found in the pith of such quick growing plants as the kidney bean, as well as in that of conifers.

Slight thickening is seen on the cellulose wall of many pith cells, as in the elder, and less frequently it is more developed, as in *Fraxinus*, *Cycas*, &c., while in a few cases, as in *Clematis* and *Hoya* there is great thickening.

The air passages arise by resorption of rows of cells often abnormally formed, and are well seen in water-lilies and other aquatic plants, and occasionally a few scattered bast bundles and milk vessels may be found in pith.

The pith continues active during the whole life of the plant, and constitutes a store of reserve material during the resting period for the changes set up at the time of renewed growth.

3.—CORTICAL TISSUE.—This includes that portion of the stem lying between the fibro-vascular bundles and the epidermis or cork, and in leaves between the cuticle and vascular bundles of the nerves; it is therefore most distinct in parts exposed to the air and light The primary bark proceeds directly from the primordial tissue of the growing point, and rapidly increases by cell division. In annual plants it is completed simply by extension of these cells, as it is also in perennial plants which cast off their bark by cork tissue arising under it; but in those like the holly and the mistletoe,

which do not do so, certain portions of the cortical tissue, by mother-cells, continue to reproduce new tissue of the same kind.

Cortical tissue consists entirely of parenchym cells, which in leaves usually remain with thin walls, but in the stem are variously modified and may be divided into an inner and outer rind.

The inner rind is formed of layers of thin-walled spheroidal cells, with their surfaces only slightly in contact, and thus interrupted by apertures of various sizes. Lignification of the cellulose case very rarely occurs, but in a few instances groups of strongly thickened cells are seen, distinguishable by their size and colourless contents; the ash, beech, laburnum, and hoya afford examples. The contents of the cells of this layer are starch, with the addition of chlorophyl in the more external, and in some instances crystals are also present. Again in milky-juiced plants bast vessels occur, which are connected with similar vessels of the bast bundle, and single and grouped bast cells are seen in the inner cortical layer of the leaf stalk of cycads and the bark of many palms. Within this layer also occur the resin, oil, and gum canals peculiar to many plants.

The outer rind, Collenchyma.—The outer layer consists of rounded parenchyma cells with little or no thickening, but often more or less elongated, or the cells have all irregular strong thickening of their walls or angles, and then constitute *collenchyma*. When the outer layer of this sub-epidermal tissue consists of thin-walled parenchyma and collenchym cells, the latter are in groups overlying the bast part of the vascular bundle, while the thin-walled cells reach the epidermis, and are opposite the medullary rays; in these cases the collenchyma is often greatly elongated. The collenchyma has no intercellular spaces, and may take the form of longitudinal strings of cells lying under the epidermis, as in the stem of *Equisetum* and leaves of *Pinus;* or it may be seen as a connected layer, only perforated by the stomata, in the stems and petioles of many plants, and also in many leaves as a well developed layer, *e.g.*, in the vine, elder, and begonia. The cellulose case is usually soft, but in a few instances lignified, as in *Angelica sylvestris*, and in others shows porose, netted and spiral thickening, *e.g.*, *Sambucus*, *Helleborus*. The contents are clear or red sap, and also starch and chlorophyl.

4.—Cork Tissue.—Cork is of much more frequent occurrence in plants than may be generally supposed, and moreover it is Dame Nature's plaister with which she heals up the wounds left by fallen leaves, or if any soft organ be injured, a firm skin of

new cork cells rapidly protects the sound tissues from the outer damaged structures. The walls of this tissue are highly resistent to the various reagents, behaving in this respect like the cuticle, being also elastic and with difficulty permeated by air or water; the cells are rectangular without intercellular spaces, are arranged in rows at right angles to the surface, and mostly lose their contents and become filled with air; the cell membrane is but moderately thickened, and is soon altered into cork. Primary cork tissue arises later than the other elements, and the altered parenchym cells, which become the mother cells of cork, may be either cells of the cuticle, of the collenchyma, of the inner rind, or of the parenchyma of the bast part of the vascular bundle; these mother cells repeatedly divide, and of these newly arising cells in each radial series, the inner one remains thin-walled, filled with protoplasm, and constantly forming new cells by division, and this is termed the *cork—cambium* or *phellogen layer*, while the outer becomes suberified and permanent. Generally the cork first commences at single points, but these gradually coalesce, and the phellogen forms a continuous layer, from which constantly new cork layers are being pushed outward and constitute the *periderm.* Sometimes the cork cells become altered in form, and the periderm consists of alternate laminæ of different shaped cells; this is seen in the cork of the cork-oak, and of birch. As examples of cuticular development of cork we may mention the apple tree, oleander, mountain-ash and *Viburnum Lantana*, here the epidermal cells divide into two daughter cells, the upper of which with the cuticular layers and tertiary cellulose case become suberified, and the lower becomes the mother cell of the next cork formation. In the greater part of our trees, as in the maple, beech, oak, elm, plum, horse-chestnut, elder, &c., the collenchym cells lying next under the cuticle become the mother cells of cork; and among the number of plants in which the cork tissue arises deeper below the cuticle, but yet within the outer rind, *Ficus elastica* and *Robinia pseudacacia* are well suited for observation; here the cells of the second or third row of collenchyma become the mother cells of the cork. In the bramble and currant bushes the cork tissue arises in the inner rind, and indeed it is the cells next to the vascular bundle which become the mother cells, so that all the young cortical tissue becomes pushed off by the cork tissue.

In many cases it is not solely cork cells proceeding from the

phellogen which give the thickness to the periderm, but parenchym cells containing chlorophyl are also formed; these, however, are always the daughter cells of the phellogen lying on the inner side which become thus metamorphosed, and constitute what Sanio terms the *Phelloderma*, very well seen in the currant tree.

Bark.—After production of more or less numerous cork lamellæ, the phellogen dies or loses its vital activity, but a development of secondary cork tissue takes place within the bast part of the vascular bundle, in the form of tangential rows of tabular cork cells, which loosen from the growing outer part of the vascular bundle. The cork lamellæ, as it were, cut out and force off from the rind, flat pieces in form of scales or rings; all this outer part is dead, and the process oft repeated from the circumference of the stem, causes the new cork lamellæ to become gradually embedded more deeply in the growing cortical tissue, and we get a constantly thickening peripheral layer of dry tissue separating from the living part of the rind; this is the bark. The condition is very evident in the large scales of bark in *Platanus orientalis* or sycamore, and in old stems of the *Pinus silvestris* or Scotch pine, and in the ring-like bands of the cherry tree. In the oak, lime, poplar, elder and horse-chestnut similar plates of thin-walled cells arise in the interior of the bast bundles, but the old dried scales do not fall off, but tear only at the margins in a longitudinal direction, so that the stem becomes clothed with bark consisting of several dead scales lying under each other, presenting internally all the elements of bast, and externally primary cork tissue. In the pine and larch we have a fissured periderm, like that of the horse-chestnut, and in the pine consisting partly of thin-walled and thickened cells in alternate layers, but the conifers are specially remarkable for the presence of a spurious large celled parenchym tissue, which appears between the periderm layers and separates the elements of the bast bundle into smaller or larger groups.

Lenticels.—These are due to a peculiar local cork formation, and appear as little roundish spots on the annual shoots of trees, while the epidermis continues uninjured, and before the periderm is formed. In the second summer the epidermis splits longitudinally over the lenticels, and they form more or less prominent warts, which by a median furrow frequently become bilabiate; their surface is mostly brown, and their substance to a certain depth dry and corky. By

growth in thickness of the shoot, the lenticels become expanded into transverse striæ, then cork or bark forms and splits the rind beneath them, the bark scales off, and so they disappear.

5.—Cuticle.—This covers all the external parts of plants, originates immediately from the primary parenchyma, and consists only of a single layer of cells, and as these continue for a long period capable of reproduction, the cuticle is thus enabled to keep pace with the increase in thickness of the stem; by the full development of cork it is, however, eventually cast off. It has received the names of *epithelium*, when thin and first formed; *epiblema*, when slightly thickened and covering the subterraneous parts, and both these forms are deficient of stomata; *epidermis* when fully developed, as we see it on leaves, and the green rind of stems. The cuticle is always composed of flattened or tabular parenchym cells, which in that of seeds acquire a more or less prismatic form, and in quick growing plants become considerably elongated. In most cases the cells of the cuticle are thickened by secondary deposit, which is usually confined to the outer side, and their contents, so long as they are capable of division, consist of protoplasm with the nucleus and cell sap; in a few cases starch and crystals are also met with.

Stomata.—These are openings in the cuticle which afford direct communication between the atmospheric air and that contained in the interior of the plant, hence in the higher plants they are found on leaves and green stems growing in air, but not on those submerged in water, and their number is very variable in different families, and on different sides of the same leaf; thus in the mistletoe a square inch of the cuticle is computed to contain 200, but the same extent of surface on the underside of a leaf of *Hydrangea quercifolia* contains 160,000, while the upper surface has none. The stomata are quadrate or oval in outline, and originate in an epidermis cell which divides into two sister cells of a semilunar form, and these become the guard cells which protect the orifice. In some of the lower plants, as *Marchantia*, the guard cells are absent, and the stoma is an open channel built up of several series of cells.

The stomata are situated on both sides of a leaf, but usually their most frequent seat is on the underside of aerial and upper side of floating leaves, and their arrangement may be in rows, as in *Pinus*,

and *Phormium tenax*; in groups, as in oleander, *Saxifraga sarmentosa*, &c., or scattered, as in *Euonymus japonicus*; and in relation to the epidermis, they may be above it, or on the same level, or below it. In some plants the stomata are hollows supplied with projecting hairs or prickles, as in *Nerium* and *Dasylirion*.

Appendages of the Cuticle.—Very frequently the epidermal cells become prolonged outward into papillæ, or by further growth produce hairs, scales, stings or prickles; in all these, when very young, an active circulation of protoplasm is visible.

Papillæ are simply elevations of the epidermis, and are well seen on the petals of the Pelargonium, Scarlet Verbena, and other lustrous flowers. *Hairs* are more elongated, and are seen in their simplest form on the roots of *Pteris* and *Equisetum*. Next come the woolly hairs on the leaves and young internodes of many plants, as in the horse-chestnut, where they are cast off in a felted mass when the leaves unfold, or they may remain as a woolly coat, as in *Stachys Germanica*. Again, hairs are termed *simple* when arising from a single epidermal cell, and *compound* when consisting of one or more cell rows, and both these kinds may assume a branched or stellate form, the hairs of the Mullein and the beautiful violet hairs on the stamens of *Tradescantia Virginica* are examples. Both these kinds also may bear at the point a globular cell, which usually contains an odoriferous, sticky, coloured fluid, and such are named *glandular* hairs; the *Geraniaceæ*, *Caryophyllaceæ*, and other families, afford numerous examples of these, and a beautiful specimen may be mentioned in the *Chenopodium Bonus Henricus*, where they cluster on the backs of the young leaves and stems, like groups of seed-pearls. To the class of hairs also belong the *ramenta*, or chaffy scales, common on ferns; they are flattened hairs. Frequently the end cell divides and grows out in a radial direction, forming a shield-like *scale*, as in *Elæagnus angustifolia*, *Pinguicula vulgaris*, *Hippophäe*, *Shepherdia*, &c.

Bristles differ from simple hairs only in having a stronger cellulose case, often remarkably thickened like warts, and lignified, while the epidermis at their base is somewhat elevated, and surrounds them like a wall; the Borage family affords many examples.

A similar condition is seen in the *stinging hairs* of the nettle family, Loasaceæ, &c. An indurated conic hair-cell is by its broad

base sunk in the top of a projecting many-celled papilla, in which is secreted the irritant material (supposed to be formic acid) which flows into the puncture produced by pressure on the hardened point, the little terminal knob having first been broken off.

Prickles consist of a somewhat elongated complex of epidermal cells, frequently lignified, which, at the point, runs out into a single, strongly-thickened, usually curved, sharp-pointed cell.

Illustrative Figures.—Plate XIV.

1.—Part of a transverse section through the growing point of a Fig-tree. × 1200.

2.—Part of a transv. section of a branch of Black Currant, showing cork formation. × 500. *e*, epidermis. *b*, bast cells. *p c*, bark parenchyma. *P*, entire product of the phellogen *p g*. *c*, radially arranged cork cells, arising centrifugally from the phellogen. *p d*, phelloderma, arising centripetally from the phellogen.

3.—Transverse section through the leathery cork of the Birch. × 660.

4.—Vertical section through a stoma of *Helleborus viridis*. *s t*, stoma. *e*, epidermis. *r*, rind of leaf. *a*, air cavity.

5.—Section through the under cuticle of Oleander, with the stomata, *s t*, lying in a hairy pit. *e*, epidermis cells. *p*, parenchyma of leaf.

6.—Vertical section through the marginal part of the thallus of *Marchantia polymorpha*. *p*, colourless reticular-thickened parenchym cells. *e*, epidermis of upper side. *c*, chlorophyllose cells. *s t*, stoma. *w*, partition wall of an intercellular cavity. *u*, epidermis of under side, with dark-coloured walls.

7.—Sting of Nettle. × 75.

On the Histology of Plants.

By R. Braithwaite, M.D., F.L.S., &c.

VI.—Compound or Heterogeneous Tissues.

(Read June 26th, 1874.)

The Cambium layer forms a cylinder between the wood and bark, and consists entirely of elongated cells, which, like all other tissues, originate in the parenchyma of the growing point. From it the vascular bundles are developed, and all new wood and bark, by which growth in thickness is attained, and this continues active during the whole life of the plant. In Monocotyledons the cambial cells are central, and surrounded by vessels, and after a certain period their vital activity ceases, so that these plants no longer increase in thickness, but they extend in length by means of unchanged cambial cells in connexion with the end of the vascular bundles. The heterogeneous tissue is therefore confined to the vascular bundles, and when in its most complete form, all three kinds of cells enter into its composition. In the Fungi, Algæ and Lichens, no traces of them are to be found, and we first meet with them, though in a very rudimentary condition, in Mosses and Hepaticæ, where they form a ring or bundle of elongated cells, the simplest representatives of bast. From these, as we ascend the scale, we find they become more and more elaborated, until in the highest plants they acquire their greatest distinctness. This variable condition in the different groups of plants necessitates our dealing with each of them separately.

Vascular Bundles of Hepaticæ and Mosses.

Vascular bundles are not found in all the genera, but when present appear only as a collection of elongated cells, best seen in *Marchantia* and other frondose Hepaticæ, where they form a kind of central string to the middle. In the *Sphagna* we find no vascular bundle, but the subcuticular parenchym cells become indurated, and form the so-called woody layer.

In true mosses a higher development takes place, but yet only observable in certain genera ; thus in *Dicranum scoparium*, *Clima-*

cium, and some *Hypna*, the centre of the stem is occupied by a bundle of elongated parenchym cells, by which the sap is conveyed upward. In *Mnium* the central bundle is more distinct, and consists of thin-walled polygonal cells, enclosed by a ring of thickish-walled yellow cells. In *Polytrichum* a transverse section of the stem shows us that the centre is occupied by a cylinder of thickened reddish cells, around which is another of thin-walled cells, having intercellular spaces; external to this is one of regular thin-walled yellowish cells, and lastly another, one or two rows wide, with thin dark-brown walls, which forms the sheath of the vascular bundle. By longitudinal section we see that the central cylinder is a bundle of greatly elongated cells, with horizontal or oblique transverse partitions, and some fibre-like cells, surrounded by another of thin-walled parenchyma; next comes the woody cylinder, consisting of still more elongated cells, with albuminous contents, and by this part of the vascular bundle it appears that the sap is conducted, while the inner must be regarded as corresponding to pith. Looked at from a structural point of view, we must place the species of *Polytrichum* at the head of all the mosses, since in them the tissue elements attain the greatest amount of differentiation.

Vascular Bundles of the Higher Cryptogams.

These consist of tubular and elongated parenchym cells, with but a small amount of fibre cells, and in all the full development of the constituent parts is rapidly attained. This may be best followed out in Lycopods and Ferns; in the *Lycopodiaceæ*, the elements separate from the cambium cylinder at different points, and we observe internally certain narrow, quickly lignified, vascular cells, with annular or spiral thickening, and externally narrow non-lignified elements of the bast part, and from these new wood and bast elements develope.

In ferns the first formation commences at one or two points; in the cambium string there first separate one or two fine spiral vessels near the periphery, and opposite them some elementary bast fibres. These quickly increase and become thickened, while around and between them the thin-walled tissue equally enlarges by active cell-division. When still more advanced, we see a bundle of lignified spiral vascular cells of 3-7 elements, which appear to be pushed somewhat toward the margin of the vascular bundle; while opposite to these, near the margin, is a bundle of bast fibres, the ele-

ments of which increase by cell division. The completed vascular bundles in the various groups may be summarised as follows :—

In *Equisetaceæ*, the vascular bundles form a circle around the large central air passage, produced by partial resorption of the pith, and are separated from each other by layers of wide parenchym cells, which have thick walls, often coloured yellow or brown.

On the side next to the pith, the *wood part* of the vascular bundle is chiefly occupied by a large air passage, which arises by resorption of a string of elongated thin-walled parenchym cells, and into its cavity project, on each side, one or more annular, spiral, or netted vascular cells, the circuit being completed by thin-walled narrower parenchyma, which is enclosed by the above-mentioned thick-walled cells; two other groups of smaller vascular cells occur at the sides nearer the rind.

The bast-part, composed of different elements, appears enclosed by these four vascular groups, and the parenchyma surrounding the air-passage on one side, the thick-walled parenchyma forming the sheath of the vascular bundle on the other side.

The wood-part consists of only two forms of cells, the annular, spiral or netted tubular cells, and elongated starch-bearing parenchyma, which forms partly the circumference of the air-passage, partly the connection between the two outer and inner groups of vessels. In the bast-part we find three different forms of cells; the chief part consists of narrow, thin-walled, starch-bearing cells, between which are 1-3 wider, more irregular cells, containing fine granules or air; externally we see an uninterrupted series, or several small groups of cells with narrow lumen and stronger thickening of the walls, which are the true bast fibre-cells. In longitudinal section we find the arrangement to be as follows: next the air-passage are the spiral vessels, then starch-bearing bast parenchyma, thirdly bast vessels or cribrose tubes, and externally bast fibres.

In *Lycopodiaceæ*.—Here the middle of the stem is occupied by one or more vascular bundles, lying among intermediate tissue, and these are separated from the rind by several layers of thick-walled fibre-cells in *Lycopodium*, or by spongiform tissue in *Selaginella*.

The wood-part consists of vascular cells, the inner of which are wider and have scalariform porose thickening, while the outer are narrower, and show partly scalariform-porose, partly annular and spiral thickening. The bast-part occupies all the periphery of the

vascular bundle, and in *Lycopodium* runs between the separate lobes of the wood-part; its component cells are of three kinds, the fundamental mass being a strong-walled, elongated, starch-bearing parenchyma, in the middle of which are bast vessels, singly or in small groups, and lastly, true fibre-cells.

In *Ferns.*—Here the single vascular bundle, nearly circular or band-like, forms in the true stem, a circle surrounding the pith; it is usually separated from the parenchyma of the pith and rind by a sheath of parenchym cells, elongated, frequently fibre-like, thickened on one or all sides. As in Lycopods, the middle of the vascular bundle is occupied by the wood part, the circumference by the bast part.

The wood part consists of two, or often of three kinds of cells; in the former we have elongated, pointed, tubular cells, and elongated parenchyma; in the latter are added true vessels with their lateral walls differing in structure from their oblique transverse partitions. The tubular cells forming the oldest part of the vascular bundle have a narrow lumen, and annular or spiral thickening, the transverse partitions having scalariform perforation. The wood parenchyma surrounds the tubular cells and divides the wood and bast parts; its cells are elongated, and contain starch like that of higher plants; where they touch each other they are smooth, but have pores when connected with vessels.

In the bast part we find all three forms of cells, the bulk of them being thin-walled, polyhedral parenchym-cells, like those of the wood part; within these are wider cells in rows, or small groups, with granulose contents, or empty, and cibrose thickening of the walls. These are bast vessels, and external to these, near the sheath of the vascular bundle, is a group of narrow cells, with yellow secondary thickening. In the rachis of many ferns, *e.g.*, *Osmunda*, we may observe on the inner side of the vascular bundle one or more strings of peculiar parenchymatous cells, probably adapted to receive secretion, and representing the resin or milk vessels of higher plants.

In Rhizocarpeæ.—This small group comprises only the genera *Marsilea*, *Pilularia*, *Salvinia*, and *Azolla*, and has not been much investigated. In the stem of *Marsilea* the vascular bundle appears as a ring which surrounds a central cylinder of very thick-walled brown fibre cells, and is separated externally from the cortical tissue by a hollow cylinder of similar cells, in series, which become

more thickened as they approach the surface, until hardly any lumen is seen in the most external. The wood part is also in form of a ring, which is only interrupted on one side by a small strip of bast, uniting the bast tissue on the inner and outer side of the wood.

Vascular Bundles of Monocotyledons.

These, in the most perfect condition, comprise all three forms of cells, which are arranged in two groups, constituting a wood and bast part in each vascular bundle. These arise from the cambium, and it is that portion next the pith which becomes transformed into wood, and that on the cortical side which becomes bast. The cambium quite disappears with the full development, being transformed into permanent parenchymatous tissue. Many variations occur in the development of the individual elements, and their position to each other. The wood fibres are more or less thickened, and always lignified and scattered; faintly bordered pores occur in them. The bast fibres resemble the wood fibres, but have more pointed extremities, and are thickened in various degrees. The tubular or vascular cells of the wood part consist of annular, spiral, netted, or porose vessels, which communicate with each other by a large pore or scalariform perforation. The bast vessels were called by Von Mohl *Vasa propria*, and lie between the parenchyma surrounding the vessels of the wood and the bast fibres; besides these bast vessels of the vascular bundle, there occur in certain genera, especially in *Liliaceæ*, *Musaceæ*, and *Araceæ*, wider bast vessels close under the rind, with latticed partitions, which carry a peculiar coloured sap, and have been regarded as milk vessels. They belong to the bast part of the vascular bundle.

The parenchym cells occur in both parts, and are usually much elongated, and known from fibre cells by their horizontal transverse partitions.

We follow out the origin of the vascular bundles and gradual onward formation of the individual elements from the cells of the cambium layer, either from the germinating seed or in the buds from the permanent shoots of the plant; the young date palm, *Ruscus*, and *Liliaceæ* are well fitted for the purpose. The first elements of the Vascular bundle are some bast fibres, then in the wood part we observe one or two annular vessels, following the formation of young wood cells. While by little and little the bundle of bast fibres becomes enlarged, and the thickening pro-

gresses, there is developed in the wood part the oldest spiral vessels, and at the same time the thin-walled cells of the bast part; then the central cambium loses its capacity for continued formation, and the growth in thickness of the vascular bundle before us is completed.

The general arrangement of the vascular bundle in monocotyledons is as follows:—The two ends of the radial diameter are occupied by bundles of fibre cells, those of the bast being on the cortical side, those of the wood next the pith, the other elements becoming intermixed; inward from the bast fibre bundle the bast vessels are intermixed with bast parenchym cells, and within the wood fibre bundle the tubular cells or vessels are partly surrounded by, partly intermixed with, wood parenchym cells. The most distinct type is seen in that belonging to leaves, or going off to them, as in *Iris*, *Phormium*, *Alpinia*, &c.

In the vascular bundles of grasses, the youngest wide porose vessels stand at each side, so that they enclose the parenchym cells of the wood part along with some narrower vessels; internally are placed two or more spiral or annular vessels in a single series. In palms we see in the centre of the vascular bundle 1-3 larger vessels often with some narrower spiral vessels behind them, the wood fibres being few and faintly thickened, while the bast fibres are numerous and strongly thickened. In *Liliaceæ*, *Tradescantia*, *Asparagus*, &c., the bast and wood fibres are but faintly thickened. In *Alisma Plantago* a great deviation takes place from the ordinary type of arrangement. Here we find on the inner side of the vascular bundle a wide air passage, which is surrounded by thin-walled, elongated, unlignified parenchym cells, and then by a crescent of strongly thickened wood fibres from the parenchyma of the intermediate tissue.

A peculiar condition of the two constituent parts of the vascular bundle appears in roots. Here the usually elliptic bast bundle, composed of internal bast vessels and external bast parenchyma, stands between the radially placed rows of wood vessels in a thin or thick-walled wood-like intermediate tissue of fibre cells, which gradually pass over into the tissue of the pith.

Vascular Bundles of Dicotyledons.

These in their earliest stage of formation agree completely with those of Monocotyledons, but in their perfect state they attain to various degrees of complexity.

Disunited Vascular Bundles.—These lie isolated in the tissue of the stem, and become separated from each other by layers of thin-walled bast, with strongly-thickened parenchymatous intermediate tissue. Such separated vascular bundles come nearest to those of monocotyledons, and may be seen in the stem of *Ranunculus*, *Cucurbita*, *Bryonia*, *Taraxacum*, &c. The wood part consists of a few elongated porose wood cells, thin-walled parenchyma, and distinct tubular cells; the innermost, narrow, and oldest vessels are annular, then come wider and narrower spiral vessels, then netted, and lastly wide vessels with bordered pores. The bast part contains at its margin, next the bark, a bundle or crescent of bast fibres, as in the *Papaveraceæ*, which sometimes approach to elongated parenchyma, as in the stem of *Cucurbita*. Internal to these come the bast vessels with net-like perforations, and having narrower elongated parenchym cells intermixed.

Not unfrequently a second bast bundle of thin-walled cells is seen bordering on the wood part toward the centre of the stem, as in *Bryonia*, *Cucurbita*, &c.

The Cambium layer undergoes a complete transformation in its later period of development, and loses its capacity for continued formation, just as in Monocotyledons.

Annular Vascular Bundles of Herbaceous Plants.—The transition from the last group to that seen in ligneous plants may be observed in certain *Umbelliferæ*, as *Conium*, *Daucus*, &c., and also in *Lactuca*, where the bast bundles are separated yet farther apart by a layer of formative parenchyma, *the thickening ring;* at first a closed cambium cylinder, connected with the cambium of the vascular bundle, and from this passing into a continuous ring, only interrupted by narrower medullary rays, and in which isolated smaller groups of cambial cells develope into vessels.

In many plants of this group a large part of the bast vessels are transformed into milk vessels, which anastomose with each other, and with corresponding vessels in the bark.

Vascular Bundles of Woody Dicotyledons.—These form in the older internodes a completely closed ring, originating from isolated strings of cambium, from which the separate elements are formed, and which, as in herbaceous plants, unite into a closed ring by further continued growth. At the end of the first year's growth the vascular bundles resemble those described above, bast vessels appear in the wood-mass lying between the primary bundles, nor

does the cambium lose its formative capacity at the close of this period. In the resting period of temperate climates these cells remain in the cambial condition, so that on the renewal of growth in the whole extent, they may develope from new matter the different elements of the vascular bundle.

The wood and bast parts in this group attain their highest development, and the three elements of each are far better defined than in the vascular bundles of herbaceous plants, and also by transverse section we plainly distinguish the primary medullary rays, or *Pith-bark rays*, and the secondary medullary rays, or *Bundle rays*, the former passing completely through, the latter, only reaching a greater or less depth, according to the amount of growth.

A. *The Wood part of the Vascular Bundle.—The Wood fibres*, or fibre cells of the wood, originate from the elongated parenchym-like cells of the cambium, and by subsequent extension acquire the fibre-like form. In the perfect state they exhibit many differences in the amount of thickening of their walls, and also in the form of the secondary thickening layers. In the annual ring we find this secondary thickening far more strongly developed in the outer wood cells or autumn growth, than in the inner or spring growth, and this is especially noticeable in Conifers. The thickening layers are porose, with spiral thickening also in the youngest, and the pores are always bordered, the border being circular, and variable in width, and the pore canal usually slit-like and oblique. The pores are open when they communicate with each other or with vessels, but closed by a partition in those true wood cells which later are used for storing up starch and other reserve material (*Clematis*, *Hedera*). In some cases a new formation of cells takes place in them by tranverse partitions (*Vitis*, *Hedera*, *Rubus*, &c.) and these constitute a transition to the next form.

Wood Parenchyma.—The parenchymatous cells of the wood are seen in nearly all woody dicotyledons, but are not found in *Berberis*. Their walls are less strongly thickened, the unbordered pores are always closed, and spiral thickening does not occur. Their position varies; sometimes they surround the vessels in single layers or in groups, sometimes they form connected concentric bands, or sometimes they occur singly or scattered in irregular groups.

Wood Vessels.—The tube cells of the wood are formed by solution of the transverse walls, thus constituting vessels as

already described. All three forms, annular, spiral and reticular, are found near the pith in the youngest part of the Vascular bundle, while in the older parts, only bordered porous vessels occur. They are most numerous, either single or grouped, in the inner and middle portions of the annual ring, while in the outer part or autumn wood they are often absent, or scattered singly (*Fraxinus*), or forming mixed groups with the other two kinds (*Quercus*); the vessels of the spring wood have a much wider lumen than those formed in autumn.

In *Viburnum, Carpinus, Betula*, &c., only scalariform vessels are found, while in *Lonicera caprifolium, Fagus sylvatica*, and *Platanus*, both scalariform and porose occur together. In old vessels a peculiar cell formation takes place in the interior, so that the whole becomes filled with roundish thin-walled cells, and these appear to proceed from the surrounding parenchyma, which grows inward through the pores; we see this in *Nerium, Cucurbita, Vitis, Robinia*, &c.

B. *The bast-part of the Vascular bundle.—Bast fibres.*—These also proceed from the cambium at the same time as the wood, but from that part next the bark; their form is spindle-shaped, and only in rare cases truncated at point as in some *Cacteæ* and *Euphorbia*. Branched bast cells occur especially in *Asclepiads* and *Apocyneæ*, as in the leaves of *Hoya* and *Vinca*, those of the stem being mostly unbranched and with narrow lumen; partitioned bast cells occur in the vine, some *Cacteæ* and *Sambucus racemosa*.

Except in a few plants (*Urtica dioica, Vitis, Ficus elastica* and the *Solanaceæ*), the thickening of the wall is very marked, and shows distinct lamination; but this secondary thickening is frequently perforated by simple or branched pore canals, as in *Clematis* and *Brugmansia*, the pores being unbordered, and spiral thickening also occurs; in most cases the whole of the thickening layers are completely lignified.

The arrangement of bast cells in the Vascular bundle is very variable; in many plants, as in the Beech and Birch, they form connected groups of greater or less extent, which stand at the edge of the bast part next the bark and laterally are only separated by the medullary rays; in others, as *Clematis, Vitis*, &c., they form radially arranged rows of one or more cells, or as in *Tilia* and *Begonia* similar groups of larger size; in *Hoya, Asclepias*, &c., they are scattered in the bast part. In the young state the contents are protoplasmic granular sap, but afterwards air.

Bast Parenchyma.—This sometimes alternates with the bast vessels, forming broader or narrower tangential bands, but sometimes it is scattered more irregularly between them, and agrees with wood parenchyma in structure ; its walls, however, are less strongly thickened, and these thickening layers usually remain unlignified. The contents during the resting period are starch, which becomes dissolved at the commencement of renewed growth, and in the old bast parenchyma of ligneous plants, crystals of oxalate of lime are also seen.

Bast Vessels.—Lattice-cells or cribrose tubes are found sometimes scattered irregularly through the bast parenchyma, singly or in groups (*Clematis, Acer, Fagus*), sometimes arranged in tangential bands of one or more rows, often including single parenchym cells (*Bignonia, Tilia, Vitis*, &c.). The laticiferous bast vessels may be scattered within the bast-fibre groups, or occur at their outer border, or pass even into the cortical tissue (*Ficus, Nerium*, &c.), and in *Carica* they stand between the vessels of the wood part, as well as in the bast part and the bark.

Intermediate Tissue or Medullary Rays.—This appears either *between* the primitive Vascular bundles, in few or many rowed series of cells, running in a radial direction, or *within* them, in one or few rows. In the former case it proceeds immediately from the tissue of the thickening ring which separates the cambial bundles from each other, and reaches from the pith to the rind, and thus keeps divided the primitive Vascular bundle. These are named *Pith rays* or *Pith-bark rays.* In the latter it takes its origin immediately from the cambium of the Vascular bundle by division of the cambial mother cell, and we may distinguish it into *Primary bundle rays*, which arise in the primitive bundle, and *Secondary bundle rays*, which first appear in the later formed wood and bast. By the bundle rays the wood and bast parts become cleft into smaller wedge-shaped bundles projecting more or less deeply into the substance, but always most distinctly seen in the wood.

The Pith-rays and Bundle-rays of woody Dicotyledons consist of parenchym cells greatly elongated in a radial direction, but with the other diameters much shortened, so that in longitudinal section they form a muriform tissue ; at the ends, however, next the pith and the bark, the cells are more equal in diameter, because they proceed from the primitive dividing tissue of the cambial bundle. The thickening of the cellulose case is faint in the bast

part of the Vascular bundle, and only moderate in the wood; in the bast part the cellulose case of the intermediate tissue remains unlignified, but is generally lignified in the wood part, and only in rare instances we find portions of the Primary rays changed into hard, strongly thickened woody tissue (*Fagus*, *Betula*); closed pores alone are found in the thickening layers.

The contents during the resting period are always starch granules, but at the growing period these are few and floating in other formative material. The size of the cells and number of rows in each Bundle-ray vary in different species of trees, and are of importance in studying the structure of their wood.

Vascular Bundles of Cycads and Conifers.

These agree in their mode of origin with those of Dicotyledons, but differ in the occurrence of single forms of cells, and their more composite arrangement, so that the wood and bast parts may be at once distinguished from those of other trees.

The Wood part.—Wood fibres. The fibre cells form the principal mass of the wood, and always show distinct large bordered pores; the border being circular or sometimes elliptic, but very rarely angular as in the root of *Araucaria* and wood of *Cycas*; the pore canal is also circular, but in *Cycas* slit-like. Besides the porose, spiral thickening also occurs; the secondary thickening does not show lamination, but in the wood of our Conifers we find that in the outer or autumn part of the annual ring the cells are so strongly thickened that scarce any cavity is left, but in the inner or spring part there is only slight thickening.

Wood Parenchyma.—This is the same as in other trees, but is less generally distributed; in Cycads it is present as single cells or in small groups, but in *Araucaria* altogether wanting; in *Abies* it forms scattered cells in the wood substance, which at an older stage become turpentine canals; in *Pinus* and *Larix* it is not scattered, but forms the circumference of the turpentine canals.

Wood Vessels.—The tube cells are never wanting in the primitive wood bundle of *Cycadeæ* and Pines, and appear with spiral or netted thickening. They are absent from the older wood of Cycads, and also from *Abietineæ*, *Cupressineæ*, *Araucaria*, *Taxineæ*, and *Podocarpeæ*. In *Gnetaceæ* only true vessels with porose thickening occur through the whole wood substance.

The Bast part.—Bast fibres. The fibre cells have a similar structure to that of other woods, and appear in *Cycadeæ* in the

bast part of the stem, in groups separated from each other by the other elements; in *Pinus* they are wanting, or scattered in the other elements.

Bast Parenchyma.—The parenchyma cells in *Cycadeæ* alternate with the bast vessels without any regular order in the groups, bounded internally and externally by bast fibres and laterally by pith rays. In the Vascular bundles of Conifers they are more regular, so that in *Abietineæ* and *Araucariæ*, a certain serial arrangement in a tangential direction is evident, while in *Cupressineæ* and *Taxineæ*, they stand between the rows of bast vessels. In all the contents are starch, and in *Cycas*, and more rarely in *Pinus*, crystals are also present.

Bast vessels.—The tube cells in Cycads are placed irregularly among the parenchym cells, but in *Abietineæ* they are in radial two or more celled rows, interrupted by a row of parenchym cells; in *Cupressineæ* and *Taxineæ* they stand between the bast fibres and bast parenchyma, the latter forming a central row.

The Intermediate Tissue.—This also agrees with that of other trees, and in *Cycadeæ* the primary rays as well as the bundle rays are only faintly thickened, and not lignified, while in Conifers the thickening is moderate, and lignification takes place in the whole cellulose case, except in the membrane closing the pore canals. The medullo-cortical rays of Cycads consist of several rows, and become wedge-shaped toward the outer part of the wood, to widen again in the bark; Conifers have only one or at most two-rowed rays, and possess in the wood and bast parts an equal number of cell rows. The bundle rays both of Cycads and Conifers are only small and of single rows, though here and there in the Larch, *Pinus Canariensis*, &c., rays of two or three cell rows occur.

Air, or Peculiar Sap-canals in the Vascular Bundles.

In the tissue of the Vascular bundles of Vascular Cryptogams, Mono and Dicotyledons, we find in certain genera peculiar receptacles like those occurring in pith and bark, which carry air or excreted matters, and known as air passages or sap receptacles. We find air passages only in the Vascular bundles of *Equisetaceæ*, and certain Monocotyledons, and in the former they originate in the stem by resorption of a string of vessels and parenchyma, in the root partly by resorption of a large central spiral vessel; in the latter they owe their origin to a similar

process and to empty milk vessels. The receptacles of peculiar secretion are most frequent in the bast part; the resin canals in the wood of *Pinus*, *Abies*, or *Larix* always consist at first of a string of thin-walled unlignified wood parenchyma, enclosing a small intercellular passage, formed by the retiring apart of a few central cells, whose contents in the resting period are starch, which later becomes changed into volatile oil and balsam. In *Pinus* the thin-walled parenchyma surrounding the central intercellular passage, which increases by division, often very early and before its cellulose case becomes lignified, is partly or wholly resorbed in consequence of resin formation.

The wide milk passages occurring in the bast part of the Vascular bundle of *Rhus*, &c., arise also from strings of thin-walled elongated parenchyma, grouped round an intercellular passage, and represent partly the bast vessels.

The milk passages in the rind of *Alisma*, and also the oleo-resinous passages in the middle or in the circumference of the bast part of many Umbelliferæ, as *Angelica sylvestris*, proceed on the contrary from the drawing apart of a string of thin-walled elongated parenchym cells, by which intercellular passages result. The wide air or milk passages of *Aroideæ*, undoubtedly arise from the resorption of one or two wide spiral vessels. In all these investigations it is hardly necessary to observe that very thin transverse and longitudinal sections are required, and that we frequently must examine them after treatment by various re-agents; the amplication also for correct determination of minute structural details will often require powers of 300 to 500 diameters.

Illustrative Figures —Plate XV.

1.—Transverse and longitudinal sections from the middle of the stem of a moss, *Polytrichum commune*. × 360. *P*, the pith with irregularly thickened cells *a*, and thin-walled cells, *b*. *V*, elongated thin-walled cells of the Vascular bundles. *Pc*, parenchyma of stem.

2.—Transverse section of the Vascular bundle of *Alisma Plantago*. *a*, air passage. *p*, thin parenchym cells. *v*, vessels. *Bf*, bast fibres. *Bv*, bast vessels. *Bp*, bast parenchyma. *Wf*, woody fibres.

3.—Developement of Turpentine canals. *A*, transverse section at the apex of a shoot of *Pinus Picea*, in the rind of which the small group of dividing starch-bearing cells, *Wp*, has separated from the other chlorophyllose cells *p*, to form the future Turpentine canal, *Tc*. × 1000. *B* and *C*, transverse and longitudinal sections of a perfect canal. The internal cavity, as well as the thin-walled cells *wp*, are filled with semi-fluid resin, while the thin-walled compressed cortical cells *p* still contain a small quantity of starch. × 800.

ANNUAL SOIRÉE.

April 17th, 1874.

The annual Soirée was held in the Library and Museum of University College, which were, as heretofore, placed at the disposal of the Club by the permission of the Council. The number of visitors exceeded 1,000, but the rooms were less crowded than usual, owing to the increased space allotted for the purpose of exhibition in the Museum.

One hundred microscopes were exhibited by members of the Club, and nearly fifty by members of the Croydon, the South London, the Sydenham and Forest Hill, and the Tower Hill Microscopical Clubs.

The leading London opticians contributed greatly to the success of the evening by a brilliant display of microscopes, spectroscopes, graphoscopes, stereoscopes, &c., and also showed the latest improvements in objectives and apparatus, filling the bays in the Library in a very effective manner.

The following list of objects exhibited by members of our own and the other Microscopical Clubs is necessarily imperfect, as many of the exhibitors' cards were not filled up :—

Circulation in leg of Spider	Mr. W. Adkins.
Drum of Ear of Frog (injected)	Mr W. Allbon.
Sea Anemone (*Bunodes crassicornis*) ...	Mr. Alstone.
Raphides of Echinocactus ... ... ,, Prickly pear ... ... ,, Water Lily...	Mr. F. W. Andrew.
Ova in ripe segment of Tape-worm (*Tænia serrata*)	Mr. Hy. Ashby.
Sole Skin	Mr. Atkinson.
Stamens and Pollen of Mallow	Mr. T. J. Baker.
Eggs of Common House Fly	,,
Cimex (*Tingis crassicornis*)	,,
Circulation in Tadpole	Mr. E. Bartlett, jun.
Hydra viridis	,,
Ringworm	Mr. W. A. Bevington.
Proboscis of *Vanessa Urticæ*	,,
Stellate hairs of *Arabis alpina*	Mr. G. Bird.
Capsule and bulbils of *Lunularia vulgaris* ...	,,
Feathers of Humming Bird	Mr. W. Bishop.
Circular crystals of *Brucia*	Mr. W. J. Brown.
Platino-cyanide of Magnesium	,,
Larva of Crab	,,
Bones from Mouth of Star Fish	Mr. Geo. Browne.
Chemical Spectroscope, showing the bright lines of the Metallic Spectra of Sodium, Lithium, Strontium, and Barium ...	Mr. T. W. Burr.
Microscope, with Lunar Photographs ...	,,

Daphnia vetula	Mr. C. W. Burt.
Seed of Grass (*Agrostis canina*)	Mr. R. Catchpole.
Stephanoceros Eichornii	Mr. W. G. Cocks.
Volvox globator	,,
Section of Foot of Kitten (injected)	Mr. A. K. Coles.
Bouquet of Butterfly Scales	Mr. F. Coles.
Ophiocoma neglecta	Mr. W. R. Cooper.
Leaf of *Rhododendron Madenii*	,,
Eye of Fly...	,,
Eggs and Larva of Moth	Mr. F. Crisp.
Acari of Water Rat, &c.	Mr. J. S. Crisp.
Valisneria spiralis	Mr. T. Crook.
Section of Cat's Tooth (polarized)	Mr. P. Crowley.
Part of frond of *Hymenophyllum*	,,
Petal of *Correa*	,,
Hyperstine, &c. (polarized)	Mr. Curties.
Living Diatoms from Keston	Mr. E. Dadswell.
Plaited Horsehair (polarized)	,,
Under Jaw and Muscle of Frog	Mr W. A. Duck.
Pencil Tail (*Polyxenus lagurus*)	Mr. C. G. Dunning.
Foot of Newt (injected)	,,
Serpula and *Balanus balanöides* (living) ...	Mr. Fitch.
Section of Fossil Wood	Mr. C. J. Fricker.
Tongue of Drone Fly	,,
Water Spider (alive)	Mr. J. R. Furneaux.
Draparnaldia and other Algæ on Snail shell	Mr. F. W. Gay.
Peristome of Moss	Mr. E. George.
Hemiptera (*Tingis cardii*)	Mr. Gibson.
Platino-cyanide of Magnesium	Mr. Golding.
Fossil Diatomaceæ	,,
Stephanoceros	,,
Euplectella aspergillum, with spicula, *in situ*	Mr. Goodchild.
Foot of Dytiscus	Mr. A. Goode.
Dytiscus (alive) showing suckers on fore-leg	Mr. W. Goode.
Platino-cyanide of Strontian	Mr. J. W. Goodinge.
Eyeball of Rat	Mr. C. A. Gould.
Licmophora splendida	,,
Section of Spine of *Cidaris*	,,
Stephanoceros, Melicerta, Floscularia, &c. ...	Mr. A. C. Haddon.
Group of Feathers from Humming Bird ...	Mr. J. H. Hadland.
Gill of Eel (injected)	Mr. H. F. Hailes.
Tongue of Spider (mounted in sand-blast cell)	,,
Conochilus volvox and *Volvox globator* ...	Mr. W. Hainworth.
Mouth of Crane Fly	Mr. A. Hammond.
Flowers	Mr. G. Hardess.
Honey, shewing pollen-grains, indicating the sources from which it was obtained	Dr. Helsham.
Daphnia pulex	Mr. Hembry.
Diatoms and Polycystina	Mr. F. H. P. Hind.
Anther and Pollen of Mallow (*Malva sylvestris*)	,,
Stellate hairs—petal of *Correa speciosa* ..	Mr. C. W. Hovenden.

Vorticella	Mr. F. Hovenden.
Circulation of blood in foot of Frog	Mr. S. Israel.
Section of Pear (polarized) showing gritty tissue (*Sclerogen*)	Mr. B. D. Jackson.
Polycystina—Barbados	Mr. E. F. Jones.
Tongue of Drone Fly	Mr. J. M. Knight.
Polycystina	,,
Melicerta ringens	Mr Le Pelley.
Egg of Parasite of Gol'en Pheasant	Mr. G. F. Linney.
Urania Fernandinæ—a day-flying moth from Madagascar	Mr. S. J. McIntire.
Ascaris vermicularis, male (Human Intestinal Worm)	Mr. K. McKean.
The Electric Spark	Mr. Martinelli.
Polycystina from Barbados	Mr. J. B. Moseley.
Marine Polyzoa	Mr. Jas. Nelson.
Diatoms, arranged	Mr. H. Noakes.
Pollen of Mallow	Mr. Oxley.
Gutter life (South London)	Mr. W. J. Parks.
Polycystina	Mr. Geo. Pearce.
Brain of Rat (injected)	Mr. J. G. Price.
Natural Flowers	Quekett Club Microscope.
Platino-cyanide of Magnesium...	Mr. F. Reeve.
Philodina roseola and *Callidina* (?)... ...	Mr. W. W. Reeves.
Salicine	Mr. E Richards.
Foraminifera in Water	,,
Circulation in *Nitella*	Mr. E Robins.
Wing of Butterfly	Mr. J. Rowlett.
Melicerta ringens, *Stentor*, &c.	Mr. Jas. Russell.
Circulation in *Valisneria*	,,
Palate of *Eolis coronata* (a Sea Slug) ...	Mr. T. D. Russell.
Disc of *Asterina gibbosa*	,,
Pond life...	Mr. Sedgwick.
Section of Fossil Teeth (*Mastodon*, *Lamna*, &c.)	Mr. J. Slade.
Wing of Butterfly *Parnassius Apollo* ...	Mr. J. Simmonds.
Daphnia vetula	Mr. E. Simps n.
Hydra vulgaris	Mr. Simpson.
Spicules of Sponge	,,
Hydra viridis	Mr. W. Smart.
Circulation in Antennæ of *Asselus*	,,
Hyperstine (Sun stone)	Mr. Alpheus Smith.
Section of Blow Fly (opaque)	Mr J. A. Smith.
Insect life from Ship's bread (Weevils) ...	Mr. R. A. Smith.
Hydra viridis	Mr. C. W. Stidstone.
Melicerta ringens...	Mr. D. J. Stuart.
Head of Gnat (*Culex pipiens*)...	Mr. W. T. Suffolk.
Hydra viridis	Mr. Tafe.
Tiger or Hunting Spider	Mr. A. D. Taylor.
Eggs of Magpie Moth	Mr. Geo. Taylor.
Head of Tape-worm	,,
Snake Coralline, with diatoms, *in situ* ...	Mr. T. Terry.
Egg of Parasite of Pheasant	,,

Cyphus gemnari	Mr. Thompson.
Lower Jaw and Tongue of Salamander (injected)	Mr. A. Topping.
Skin of ditto (injected)	,,
Stomach of Eel (injected), &c....	,,
Palate of *Haliotis tuberculata*	Mr. C. C. Underwood.
Section of Fan Palm	,,
Hair of larva of *Orgyia pudibunda*	,,
Palate of *Trochus striatus*	,,
,, *Phasianella pulla*	,,
Hair of Elephant (section)	,,
Floscularia cornuta	Mr. John S. Walker.
Hydra viridis	Mr. Warburton.
Crystals of Gallic acid (polarized)	Mr. F. H. Ward.
Foraminifera	,,
Circulation in tail of Gold-fish...	Mr. T. E. Way.
Diaptomus castor...	Mr. E. Westbrooke.
Anther and Pollen of Dead Nettle	,,
Foot of *Dytiscus marginalis*	Mr. Warrington.
Girl's Hair (blonde), polarized	Mr. J. Watkins.
Gizzard of Cricket	Mr. F. West, jun.
Star-fish (*Nympha gracilis*), alive	Mr. W. West.
Flour Mites (*Atropos pulsatorius*)	Mr. F. W. White.
Seeds of *Nemesis compacta alba*	,,
Social Ascidians on sea-weed	Mr. T. Charters White.
Marine Life (*Corynactis, Hydractinia*, &c.)	,,
Eye of Beetle, showing multiplied image ...	Mr. George Williams.
Platino-cyanide of Magnesium	,,
Coal Sections	Mr. J. R. Williams.
Hydra and Snail Spawn...	Mr. R. P. Williams.
Parasites of Water Rat	Mr. Worster.
Pollen of Mallow...	Mr. E. Wright.
Collection of British Crustaceæ	Mr. T. D. Russell.
,, Minerals and rock specimens ...	,,
Graphoscope and Photographs...	Mr. H. Lee Rutter.

The additional attractions of the evening were—

A lecture on "Natural Phenomena," by Mr. James Martin, illustrated by drawings shown with the oxy-hydrogen apparatus, in the Mathematical Theatre.

Microphotographs, views, &c., shown in a similar manner by Mr. James Smith for Mrs. How, in Room 7.

The Sand-blast process, with a machine lent by General Tilghman, the patentee, in Room 2.

Mr. Vernon Heath showed his celebrated Prize Photographs of scenery and foliage in the Museum.

Mr. Rochfort O'Connor lent his beautiful drawings of microscopic objects.

PROCEEDINGS.

April 10th, 1874.—Conversational Meeting.

The following objects were exhibited :—

Ixodes of Boa Constrictor	Mr. Curties.
Jaws and Teeth of *Echinus*, polar	Mr. Freeman.
Platino-cyanide of Magnesium	Mr. Golding.
False Light Excluder for Objectives ...	Mr. Ingpen.
Elaters and Spores of *Jungermannia* on Glycerine	Mr. Oxley.
Spicules of Gorgonia	Mr. B. W. Priest.
Ætea anguinaria	Mr. Terry.
Section Foot of Salamander injected ...	Mr. Topping.
Section of Lamprey, *Petromyzon fluviatile*...	Mr. Ward.
Marine Life in Small Tank	Mr. T. C. White.
Drop from Composite Candle, polarised ...	Mr. G. Williams.

Attendance—Members, 57 ; Visitors, 6.

April 24th, 1874.—Dr. R. Braithwaite, F.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following donations to the Club were announced :—

"The Monthly Microscopical Journal" ...	from the Publisher.
"Science Gossip"	,,
"The Popular Science Review"	,,
"Proceedings of the Royal Society"	the Society.
"Proceedings of the Literary and Philosophical Society of Manchester" ...	,,
"Fifth Annual Report of the Microscopical Society of Liverpool"...	,,
"Third Annual Report of the South London Microscopical and Natural History Society"	,,
"The American Naturalist," February, March, and April	in exchange.
"The Quarterly Journal of Microscopical Science"...	by purchase.

The thanks of the Club were voted to the donors.

Mr. Enoch Walker was balloted for, and duly elected a member of the Club.

A paper by Mr. G J. Burch, "How to make thin covering-glass," was read, and the thanks of the Club voted for his communication.

The Secretary stated that he had received a letter from Dr. Hoggan, in which he desired to communicate to the meeting that his non-appearance before

them with his section-cutting machine was no breach of promise on his part. He willingly mentioned this, and regretted that Dr. Hoggan should not have been with them in consequence of a slight misunderstanding. He was expecting to receive some communication from Dr. Hoggan as to the machine, but had received none, and not knowing his address, was unable to write to him on the subject, so as to make the necessary arrangements in time.

The President said that he had at the last meeting asked Dr. Hoggan to bring his machine ; but he did not know that he would prepare a paper on the subject, and whilst regretting the circumstance of his absence, he hoped that it would be merely a pleasure deferred, and that they would be favoured with it at some future time.

Mr. Ingpen read a paper "On a False Light-excluder for Microscopic Objectives" (see p. 262 *ante*), illustrating the subject by drawings on the black board, and by the exhibition of the apparatus applied to a microscope.

The President, in moving a vote of thanks to Mr. Ingpen for his paper, said he felt sure that it was only necessary to see this little piece of apparatus in order to appreciate its value in cutting off extraneous rays.

A paper, by Mr. Jas. Fullagar, of Canterbury, "On the development of *Hydra vulgaris* from Ova," was read, and was illustrated by a number of beautifully executed drawings. Specimens of *Hydra viridis* in further illustration of the paper were exhibited in the room by Mr. Curties.

The President thought it a very interesting circumstance that a creature so low in the animal kingdom should show so perfect a manner of development. At first sight the ovisacs had very much the appearance of the statoblasts of the Polyzoa. The *Hydra* was so common, and was so often found at their field excursions, that he hoped many of the members of the Club would be able to add to the paper the results of their own observations.

The thanks of the meeting were unanimously voted to Mr. Fullagar for his paper.

Mr. Ingpen exhibited and described an Achromatic Bull's Eye Condenser. This instrument was constructed from the objectives of a binocular opera-glass, one of which was reversed in its cell, and the two cells screwed into the opposite ends of a short piece of tube, so that the flat side of one lens nearly touched the convex side of the other. The lenses were achromatic doublets. A very perfect image of the source of light was obtained, and the purity of the light was stated greatly to excel that of the ordinary bull's eye. Anyone possessing a binocular opera or field glass could construct this condenser at a very small expense, the lenses being still available for their original purpose.

The thanks of the meeting were voted to Mr. Ingpen.

Mr. Golding said he had on a recent occasion used a single photographic lens as an achromatic bull's eye, and found it to answer extremely well.

Mr. Ingpen said that on showing his condenser to Mr. White he had been asked if it would serve as a low power for dissecting. It would not do for that purpose as it was, but if one of the lenses was reversed it would answer capitally for that purpose, giving a large flat field and fine definition.

On the motion of the President a vote of thanks was passed to those gentlemen who had contributed to the success of the Soirée by exhibiting on that occasion.

Twenty-three gentlemen having been proposed for membership, the proceedings terminated with a Conversazione, at which the following objects were exhibited :—

Hydra viridis	by Mr. Curties.
Tenthredo arcuatus	Mr. Enock.
Termite	Mr. Fitch.
Ear of Mouse—injected	Mr. Freeman.
Polycistina	Mr. Golding.
Phantom Larva	Mr. Hainworth.
Bi-chromate of Potash	Mr. Hind.
Micro-photograph—Dr. Livingstone ...	Mr. Moginie.
Transverse Section of Claw of Brown Bear	Mr. T. D. Russell.
Grantia compressa	Mr. T. C. White.

Attendance—Members, 72; Visitors, 8; total, 80.

May 8th, 1874.—Conversational Meeting.

The following objects were exhibited—

Corallina officinalis, decalcified	Mr. M. Hawkins Johnson.
Holothuria (?)	Mr. T. C. White.
Skin of Dog Fish, *Scyllium canicula* ...	Mr. Freeman.
Corethra plumicornis, changing from larval to pupal state	Mr. Fitch.
Arrenurus viridis, alive	Mr. Fitch.
Thorax of Diamond Beetle	Mr. Hailes.
Eriopteryx lineata	Mr. Enock.
Scales of *Lepisma*, various	Mr. G. Williams.
Crystals in testa of seed of Elm	Mr. B. D. Jackson.
Dendritic spot on Magnesite...	Mr. Greenish.
Stained section of *Ascaris lumbricöides* ...	Mr. Ward.
Section of head of embryo Rabbit	Mr. E. T. Newton.

Attendance—Members, 56; Visitors, 3; total, 59.

May 22nd, 1874.

Dr. R. Braithwaite, F L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following Donations to the Club were announced:—

"The Monthly Microscopical Journal"	from the Publisher.
"Science Gossip"	,,
"The Eleventh Report of the East Kent Natural History Society"	the Society.
"Proceedings of the Geologists' Association" ...	,, the Association.
"Proceedings of the Bristol Naturalists' Society"	the Society.
"The American Naturalist"	in exchange.
"Monograph of British Annelids" (Ray Society's Publication)	by subscription.
12 Slides of Sections	from Mr. E. T. Newton.

The thanks of the Club were voted to the donors.

The following gentlemen were ballotted for, and duly elected members of the Club—

Dr. G. P. Bate, Mr. Edward G. Box, Mr. John J. Burgess, Mr. C. F. Burnham, Mr. William E. Callaghan, Mr. Herbert Carruthers, Mr. James Clayton, Mr. William Cole, Mr. G. Green, Mr. Ernest Grey, Mr. George Hind, Mr. C. W. Hovenden, Mr. W. W. Jones, Dr. Manly, Mr. Edgar A. Meates, Mr. G. A. Messenger, Mr. Philip C. Nixon, Mr. Thomas Palmer, Mr. George A. C. Pearce, Mr. William W. Reid, Mr. Roland D. Smith, Mr. James Spencer, and Mr. Ernest Wadmore.

The Secretary reminded the members present that at the next ordinary meeting nominations would have to be made of gentlemen to fill vacancies upon the Committee. Vice-Presidents for the ensuing year must also then be nominated, and notice must be given of any alterations proposed either in the rules or other matters affecting the government of the Club.

The President announced that he had just received an intimation of the death of Mr. T. W. Burr, which had occurred suddenly that morning. Mr. Burr was well known amongst them as one of their Vice-Presidents, and for some years also as an active member of Committee, and the Club would no doubt receive, with great regret, the announcement of his sudden removal.

Dr. George Hoggan read a paper upon his machine for section-cutting, to which reference was made at the March meeting of the Club, describing it first as originally made, and then giving in detail the various improvements and additions which experience had led him to adopt. The methods of using it for hard and soft substances were minutely described, and the original and perfected forms of the machine, as well as a large number of sections cut by it, were exhibited to the meeting.

The President, in proposing a very cordial vote of thanks to Dr. Hoggan for his paper, expressed the pleasure with which he had listened to it, and thought that the machine itself was one of the most perfect for the purpose that he had ever seen.

A vote of thanks to Dr. Hoggan was carried by acclamation.

Mr. Miller said that, as on the last occasion when this subject was before them, he had taken the liberty of saying a few words upon the subject, he should like to make one or two further observations. He confessed that he could not agree with Dr. Hoggan that complexity in a machine was not a disadvantage. He rather agreed with Dr. Klein, that a steady hand and a sharp knife were the best things to trust to in section cutting, and no one would deny that sections of considerable size had been cut by Dr. Lockhart Clark and others, which were perfect in themselves, and were yet cut entirely by hand. If anyone did want a machine, he thought the simpler it was the better, and no one would deny that the tube machine was simple and efficient; it was also cheap, and cheapness in such things was to students a matter of very great moment. For cutting perfectly fresh tissues there was nothing better than freezing, and this could not be adopted with the new machine. As to the shape of the knife, he thought one with a slanting edge was much better than one with a perfectly straight edge. As to the material for floating the sections off the knife, he thought that caustic soda was not able to be used in many cases, and if substances were kept in spirit he thought the fewer re-agents they used the better. He wished to add his protest against the use of section-cutting machines; for general purposes sections could be cut quickly and easily with the hand quite well enough for all possible requirements of study, and he was of opinion that for private purposes a section-cutting machine was quite as much of an inconvenience as an advantage.

Mr. Golding inquired if he rightly understood from Dr. Hoggan's description that the machine could in no way be simplified, and that nothing could be taken away from it without impairing its efficiency?

Dr. Hoggan said that it was for cutting hard sections that his machine was of the greatest use. Supposing, for instance, that a person brought to him, say the tooth of a fish, and wanted a section cut, it could be taken and several made from it in four or five minutes; but it would take four or five hours to prepare one in the usual way, besides which, if they could be obtained so easily it would not be necessary to take such pains in preserving them. The gentleman who had first spoken appeared to have lost the point of his remarks throughout, for he disputed points which he himself had never raised, and the suggestions which he added were just what he (Dr. Hoggan) had already mentioned. For small sections of some organic preparations, he had said in his paper that the best way was to cut them by hand, and teaze out the tissue with needles. As to the freezing, no doubt somebody would one day add a salt box to the machine, and then call it after his own name. A knife for section cutting should be flat either on one side or the other, and he never thought of denying the truth of what had been said about knives. All that the gentleman had said against caustic soda was exactly what was stated in his paper; it did very well in some cases, but certainly not in all. He did not know if the price of the machine was more than that of the latest forms of the old kinds.

Mr. T. C. White said he had come in late, and therefore had not heard the whole of Dr. Hoggan's paper; but he had brought with him a few sections of hard tissues, such as cocoa-nut palm, which had been cut by Mr. Williams with a modification of the ordinary lapidary's wheel. He could also cut quartz and sections of coal. He could quite imagine that it was often of very great importance to be able to cut hard sections so quickly. From what he could see, he should chiefly object to the machine on account of its complication, for he believed that the secret of success was not so much in the apparatus as in the section-cutter himself. He should like to ask Dr. Hoggan if he found that in cutting with a saw ridges were not left on the surface of the section, and also if he hardened the substances specially before cutting them?

Dr. Hoggan said that in the case of a number of tissues he found it best to harden them, but for one half of those which he exhibited there was no hardening whatever, except what took place in the alcohol, and some were cut without any preparation whatever—the section of kidney was cut the day after it was obtained, and without previous hardening.

Mr. White thought this a great advantage, because sections cut after hardening were apt to be spoilt by the knife, and many substances were much altered by any hardening process.

Mr. Hainworth reminded Dr. Hoggan that he had not answered the question as to the tooth marks left by the saw.

Dr. Hoggan said that if the saw were rather coarse, or if its rough edges were not taken off by rubbing the sides on a bone, marks would sometimes be left, but this would not be so if the edges were taken off.

Dr. Foulerton remarked that a good deal had been said as to the way in which hardening could be effected, but he had understood that this machine was to do away with the necessity for it, and he thought that if the machinist took this upon himself, the section cutter surely need not complain.

The President expressed the interest with which he had listened to Dr. Hoggan's paper, and hoped the Club might one day be favoured with another

paper upon the subject of hardening. He thought the only objection to the machine was its cost, for this must, in most cases, be a serious item with students, to whom shillings were often of more consequence than pounds might be a few years later. But as Dr. Hoggan had said at the commencement, a very great deal might be done with the hand, and students should persevere in this way. It was not necessary for them to make beautiful specimens for the cabinet in order to pursue their investigations. He thought that the machine which they had before them was capable of doing everything which a machine was required to do.

The President said that a little difficulty had arisen with respect to the concluding papers of his series in consequence of the limited time which now remained before the close of the current year of the Club. The next meeting would be occupied partly by the business relating to the annual meeting, and they were promised a communication of great interest also. He thought, therefore, that if instead of reading the paper it were taken as read, and he were to give a demonstration at the next gossip night, the difficulty as to time might be got over, and the objects which Mr. White had brought might, with others, form a series in illustration of the subject to be considered.

Mr. T. C. White thought that nothing could be more profitable than a demonstration on the gossip night as proposed by the President, and he was quite sure that the examination of these preparations could not fail to be of great interest. He had great pleasure in moving the adoption of the suggestion made by Dr. Braithwaite.

Mr. Greenish seconded the proposal, which, being put to the meeting, was unanimously carried.

The President said that the paper would be taken as having been read that evening. His next two papers would be upon the Tissues as a whole—the first on the Homogeneous tissues—such as pith, bark, cork, the cuticle and its appendages; and the other upon the Heterogeneous tissues, such as wood. Gentlemen who would undertake to bring their miscroscopes for the purpose of exhibiting specimens would much oblige by communicating with Mr. Jackson, who had undertaken the arrangements; and if any members would bring specimens bearing on the subject he should be glad.

Announcements of meetings, &c., were made, and the proceedings terminated with a conversazione, at which the following objects were exhibited:—

Peristome of Moss	by Mr. W. G. Cocks.
Diatomaceæ from the Fountains of St. Peter's at Rome	Mr. T. Curties.
Larva of *Tipula crystallina*	Mr. Dunning.
Aulacodiscus Margaritaceus	Mr. Glasspoole.
Eupodiscus sculptus	Mr. Hainworth.
Section of Kidney of Rabbit	Mr. F. Reeve.
Salicine (by polarized light and new arrangement of working Darker's films)	Mr. Richardson.
Section of grass stem	Mr. Slade.

Attendance—Members, 74; Visitors, 8; total, 82.

June 12th, 1874.—Conversational Meeting.

The following objects were exhibited—

Spicules of *Gorgonia*	Mr. Corbett.
Thrips minutissima (Smother-fly)	Mr. Enock.
Aphis of the Maple	Mr. Goodinge.
Circulation in the gills of Newt	Mr. Israel.
Aulacodiscus Oreganus	Mr. Moginie.
Culex pipiens	Mr. Geo. Williams.
Distillation from vapour of Coke (polar.) ...	,,

To illustrate Dr. Braithwaite's 5th Paper on the Histology of Plants.

Stomata of the White Lily	Mr. Andrew.
Glandular hairs of *Chenopodium Bonus Henricus*	Dr. Braithwaite.
Moniliform hairs on stamens of *Tradescantia Virginica*	,,
Stellate hairs of *Aralia papyrifera*... ...	Mr. Dunning.
Scales of *Eleagnus*	Mr. Golding.
,, *Correa cardinalis*	Mr. Hainworth.
Section of leaf of *Yucca*	Mr. B. D. Jackson.
Cuticle of Holly leaf	Mr. H. Johnson.
Section of Birch bark	Mr. W. W. Reeves.
,, Black currant tree	Mr. Topping.
Stomata of Cactus	Mr. T. C. White.
Sting of Nettle	Mr. T. C. White.

Attendance—Members, 70; visitors, 4; total, 74.

June 26th, 1874.—Dr. R. Braithwaite, F.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following donations to the Club were announced—

"The Monthly Microscopical Journal"	from the Publisher.
"Science Gossip"	,,
"Memoirs of the Literary and Philosophical Society of Manchester," vol. 4.	the Society.
Proceedings of the same Society, vols. 8, 9, & 10 ...	,,

The thanks of the Club were voted to the donors.

The following gentlemen were balloted for and duly elected members of the Club:—

Mr. John Badcock, Mr. Henry Brady, Mr. E. A. Fardon, Mr. John H. Gritton Mr. Joseph Gritton, Mr. W. W. Hewitt, Dr. Thomas Magor, and Mr. John R Rogers.

The Secretary announced that he had only that morning received a note from Mr. Samuel Holmes, stating that he was unable to attend the meeting and read his paper, though he had been announced to do so. On receipt of the letter he had sent to Mr Crisp, asking him to see Mr. Holmes if possible, and get him to let them have the paper to read at the meeting. Mr. Crisp had kindly sent down at once about it, but unfortunately without results; he regretted this very

much, because the paper had been advertised, and as he had understood from Mr. Holmes some time ago that the paper was then ready, he did not think it necessary to provide anything else in case of failure; they were therefore without a paper for the evening.

The President reminded the members that according to the rules of the Club, nominations must be made that evening for officers of the Society who were to be ballotted for at the next meeting; and Rule 3, which related to the matter, was read to the meeting.

The President announced the following nominations:—As President for the ensuing year, Dr. Matthews; as Treasurer and Secretaries, the same gentlemen who had filled those offices during the year now drawing to a close; and as Vice-Presidents, Dr. Braithwaite, Mr. Lowne, Mr C. F. White, and Mr. T. C. White.

The following nominations were then made for six vacancies on the Committee:—

Mr. W. A. Bevington	Proposed by	Mr. Ward	Seconded by	Mr. Crisp.
Mr. F. W. Andrew	,,	Mr. A. Smith	,,	Mr. Curties.
Mr. Golding	,,	Mr. Freeman	,,	Mr. Goodinge.
Mr. G. Williams	,,	Mr. Slade	,,	Dr. Matthews.
Mr. T. Rogers	,,	Mr. Hembry	,,	Mr. Cocks.
Mr. E. Bartlett	,,	Mr. Curties	,,	Mr. Terry.
Mr. Sigsworth	,,	Mr. Smith	,,	Mr. T. C. White.
Mr. Newton	,,	Mr. Jaques	,,	Mr. Waller.
Dr. Foulerton	,,	Mr. Golding	,,	Mr. Wright.
Mr. Nelson	,,	Mr. Marks	,,	Mr Ingpen.

In accordance with the rule, a show of hands was taken by the President in order to reduce the number to nine, and Mr. Nelson being in the minority his name was removed.

Mr. Terry objected to the taking of the show of hands, as he considered that it was entirely opposed to the principles of the ballot.

The President explained that according to the rules the number of the persons nominated must be reduced by show of hands, in order that not more than one half more than the number to be elected should be printed on the balloting papers. What had been done was strictly in accordance with the rule, which he called upon the Secretary to read. Rule III. read accordingly.

Mr. J E. Ingpen gave notice that at the following meeting he should move that an alteration should be made in rule 1, by adding the words "except August and September" after the words "every month." The object he had in view in making the alteration was to omit the ordinary meetings on the fourth Fridays in the two months named, and to make use of those evenings as conversational meetings, the same as those usually held on the second Fridays. During the summer months many members were away from home, and it was difficult to get either papers or a large attendance, and he thought it would be of advantage that they should have some little vacation, as was the case in all other societies. Of course those members who were in town would be able to attend the conversational meetings held on the usual nights instead of the ordinary meetings.

The President having ruled that this proposal must be seconded,

Dr. Foulerton seconded it.

Dr. Matthews proposed to make an alteration in rule 6, by omitting from it the word "Foreign." As the rule stood they were only able to elect *foreign*

honorary members, and he thought it might be desirable to have the power of placing others also upon this list. He proposed this alteration at the present time with reference to Dr. Sharpey, whose fame was universal, and who was now retiring from all active life, and it would be doing an honour to themselves to elect him as their first English honorary member.

Mr T. C. White seconded the proposal, which was carried unanimously.

The President invited the nomination of a gentleman to act as auditor of the accounts on behalf of the members.

Mr. Dobson was then proposed by Mr. James Smith, seconded by Mr. Gay, and elected auditor by show of hands.

Mr. T. C. White said that he had brought with him to the meeting some sections of the gritty tissue of the pear; they were not prepared from the ripe fruit, but from those pears which could at this season of the year be found in great abundance underneath the trees, prematurely cast off by blight. He had often thought that it might be possible to get the cells of a much larger size in specimens cut from very young pears in which there had not been time for the woody deposit to fill up the cells, and in these pears his surmises had turned out correct, the cells presenting the sclerogenous deposit in various stages of thickening, from a thin layer lining the cell to that wherein a mere "lacuna" is left. In addition to the specimens exhibited he had also brought with him a number of sections for distribution to any member who liked to have them. In mounting them he found that logwood stained them better than carmine, but he thought they were best when not stained at all. His specimens were mounted in a weak solution of acetate of potash, but he rather thought that gelatine would be a better medium.

Mr. F. H. Wenham thought that Mr. White would find the tissue very hard in the maturer fruit; so hard, indeed, as to require to be ground down. It was very analagous to the stone in stone fruit, and the wilder the pear the harder and more like a stone would this gritty tissue be found. Professor Quekett had described it, and had given figures.

Mr. T. C. White said he knew that Professor Quekett had referred to this woody tissue or sclerogen, and that he thought it allied to the shell of the cocoa-nut. He should be glad to hear the President's remarks about it, seeing that it came within the scope of his papers on cell growth.

The President said that he objected to the term sclerogen altogether, and looked upon it as a most objectionable and unnecessary term. It was, in fact, a condition such as might go on in any part of the plant. As to any special tissue called sclerogen, it was perfect nonsense. Lignification might take place in any of the tissues; it was really not a special condition at all, but rather a state of conversion of the tissue, and this would no doubt in certain cases be converted into stone. In the wild pear it was gritty, and the better the pear the less hard did it become. When ground down it was one of the most beautiful objects to be seen, and furnished to his mind the most beautiful evidence of design as providing for the carrying on of growth and nutrition under these conditions.

The President announced that the concluding paper of his course upon cell development would be taken as read that evening.

Mr. Ingpen described a new form of achromatic prism which was being constructed for him by Mr. Browning. In this form, the prism had plane sides, and the condensing lens was a plano-convex achromatic, the flat side of which could be placed close to one side of the prism, or removed at pleasure. The

prism could therefore be used in place of either the plane or the concave mirror.

Mr. Wenham, in reply to a question put to him, said that the principle of this arrangement was simple and obvious, and it would no doubt perfectly answer, there would be a little loss of light unless the two parts were cemented.

The list of meetings and excursions for the ensuing month was then read, and the proceedings closed as usual with a conversazione, at which the following objects were exhibited :—

Book Insect (undescribed)	by Mr. F. W. Andrew.
Plumatella repens	Mr. W. G. Cocks.
Flea of Hedgehog, with *acari*	Mr. Freeman.
Carcinus mœnas (1st stage)	Mr. J. W. Goodinge.
Microscopic Writing—(the Lord's Prayer)	Mr. Moginie.
Marchantia polymorpha (section through disc)	Mr. Slade.
Puccinia Malvacearum (the new holly-hock disease)	Mr. J. A. Smith.
Gritty Tissue in Young Pear... ... *Œcidium Urticæ*	Mr. T. C. White.
Platystoma seminationes (marble nettle fly)...	Mr. G. Williams.
Sections of Insects' eyes (showing the retina)	Mr. R. P. Williams.

Attendance—Members, 67; Visitors, 8; total, 75.

July 10th, 1874.—Conversational Meeting.

The following objects were exhibited :—

New Infusorian	Mr. Badcock.
Wing of Midge	Mr. Freeman.
Ruby-tail Fly, *Chrysis ignita*	Mr. Geo. Williams.

Attendance—Members, 37.

July 24th, 1874.—Anniversary Meeting.

Dr. R. Braithwaite, F.L.S., President, in the Chair.

The minutes of the preceding meeting were read, and confirmed.

The meeting was then made special for the purpose of correcting an informality which occurred in the nomination of Vice-Presidents at the meeting held June 26th, in consequence of which such nominations were rendered void.

The following gentlemen were then nominated to fill the offices of Vice-Presidents during the ensuing year :—

Dr Braithwaite	Proposed by	Mr. Golding	Seconded by	Mr. Jackson.
Mr. B. T. Lowne	,,	Mr. T. C. White	,,	Mr. Hainworth.
Mr. C. F. White	,,	Dr. Matthews	,,	Mr. Waller.
Mr. T. C. White	,,	Mr. Jackson	,,	Dr. Ramsbotham.

Dr. Matthews, in accordance with notice given at the meeting in June, moved the alteration of rule 6, by omitting the word "Foreign," in order to enable the

Club to elect as honorary members such distinguished persons from amongst their own countrymen as they might from time to time desire to honour in this manner.

The motion having been seconded by Mr. Greenish was put to the meeting, and carried unanimously.

In the absence of Mr. Ingpen (who was unavoidably prevented from attending by the results of a recent accident), a proposal to alter rule 1, of which he had given notice at the previous meeting, could not be laid before the meeting.

The President having requested that two gentlemen might be nominated as Scrutineers,

Mr. Reeves was proposed by Mr. Jackson, and seconded by Mr. Hainworth, and Mr. Terry was proposed by Mr. Curties, and seconded by Mr. Moginie; and upon submitting their names to the meeting, they were duly elected, and proceeded at once to the ballot.

Mr. T. C. White (acting as Secretary *pro. tem.*) then read the Annual Report of the Committee, and also the Treasurer's Annual Statement of Accounts.

The President moved that the Reports which had been read should be adopted and printed.

Mr. S. J. McIntire seconded the proposition, which was put to the meeting and carried unanimously.

The President then read his Annual Address to the Club.

The Scrutineers having handed in their report, the following gentlemen were declared to have been duly elected Officers of the Club for the ensuing year:—

As President	Dr. Matthews.
As Vice-Presidents ...	Dr. Braithwaite, Mr. Lowne, Mr. C. F. White, and Mr. T. C. White.
As Treasurer	Mr. Hardwicke.
As Hon. Secretary ...	Mr. Ingpen.
As Hon. Secretary for Foreign Correspondence	Mr. M. C. Cooke.

The result of the ballot for six members of Committee was stated to be as under:—

As Members of Committee ...	Dr. Foulerton, Mr. Rogers, Mr. Bevington, Mr. G. Williams, Mr. Newton, Mr. Sigsworth.

The retiring President then vacated the Chair in favour of his newly-elected successor.

Dr. Matthews (who was very cordially received on taking the chair as President) said—Dr. Braithwaite and Gentlemen: In my earnest desire to express my profound sense of the honour you have conferred upon me, I hope I may venture to observe that there are certain occasions in this life—and this I take to be one of them—when it may be permitted to a man to speak of himself—to be egotistical in a sense, though not in the usual sense of self-laudation. It has become a proverb, almost too trite for repetition, that self-knowledge is the most difficult, the most costly, the most deferred of all kinds of knowledge. This is well exemplified in my case, since I was not at all aware until about two

months ago that I possessed any sufficient qualifications for the office which you have now called on me to fill. Even now, at this last moment, when a hint of my unfitness—though from my own mouth—would seem to stultify your decision, which I certainly shall not risk, I entreat you to believe in the reality of my diffidence in my power to discharge the duties of this office with real efficiency. And this diffidence arises very largely from my sense of the great ability which has been displayed by my predecessors in this chair, together with a consciousness that I am neither a profound histologist nor an accomplished anatomist, as most of them have been, but simply a microscopist, though my profession has, of course, demanded of me some knowledge of both those sciences. Many now present are aware that I have devoted myself largely, or at least earnestly, to the improvement of the microscope and its manipulations, for I am well aware, gentlemen, that, in the words of a humorous and witty old friend whom I see before me, some very profound (and questionable) discoveries have been made by the aid of "a bad microscope and a lively imagination." It is from error arising in these cases that I have laboured to free our art. Amidst my—as it now seems—self-inflicted discouragements, I have taken courage from the following reflections:—First, that you have always shown yourselves indulgent to, and sympathetic with, those who have exerted themselves honestly to serve you; next, in that, after much thought on the duties of your chairman, I have come to the conclusion that he is not in that place to display his own acquirements, or to air his own knowledge, but to discharge the office of one of those bodies in nature, which, though of but minor importance in themselves, are yet capable of effecting great changes in other bodies—I mean the ferments. This function it is, I think, the proper office of your chairman to discharge, whether he does it by judicious timely observations or by pertinent inquiries, or even, now and then, by well considered papers; and I may here say that if these last be needed they will not be wanting. Gentlemen, I spoke but now of the ability of my predecessors, which I am thankful, both for myself and you, thus publicly to acknowledge; but whatever their ability, however profound their acquirements, there is one point in which I will never yield to them, and that is in my ardent desire and earnest intention to do all in my power to promote the objects and further the interests of this society. I have said enough—I fear even too much—of myself. I now am silent, that I may in future speak with the more effect of the labours and the merits of others.

Mr. S. J. McIntire proposed a vote of thanks to their late President, Dr. Braithwaite, for the zeal, learning, usefulness, and courtesy displayed to every member of the Club during his period of office

The proposal was seconded by Mr. J. G. Waller, and carried unanimously.

It was proposed by Mr. T. C. White, and seconded by Dr. Matthews, that the address which the late President had read should be printed and circulated.

Put and carried unanimously.

Mr. T. C. White proposed that a cordial vote of thanks be presented to the officers and authorities of University College for their continued kindness and generous courtesy in allowing the meetings of the Club to be held in that building.

This motion having been seconded by Dr. Braithwaite, was carried by acclamation.

A vote of thanks to the Scrutineers for the careful and efficient manner in which they had presided over the ballot was proposed by Mr. Johnson, seconded by Mr Marks, and carried unanimously.

A vote of thanks to the officers of the Club generally was proposed by Mr. Curties, seconded by Mr Gardiner, and carried *nem. dis.*

Mr. Curties inquired whether Mr. Ingpen's motion to hold conversational meetings on the fourth Fridays in August and September, in lieu of ordinary meetings, would be brought forward.

The President did not see how they could deal with it, since in the absence of both mover and seconder there was no one to lay it before them.

The following donations to the Club were announced :—

"The Popular Science Review" ...	... from the Publisher.
"The Monthy Microscopical Journal" ...	,,
"Science Gossip"	,,
"The list of Members and Annual Report of the British Naturalists' Society"	the Society.
"Frey's Work on the Microscope and Microscopic Technology" ...	Mr. T. C. White.
"The American Naturalist" ...	... in exchange.
"Quarterly Journal of Microscopical Science"	Purchased.

The thanks of the meeting were voted to the Donors.

The following gentlemen were balloted for, and duly elected members of the Club:—Mr. Thos. H. Powell, Mr. William Rushton, Mr. Jas. Wallis, and Mr. C. E. Webb.

The usual announcements of meetings and excursions for the ensuing month were then made, and the proceedings terminated.

It was remarked that, for the first time within the history of the Club, no objects were exhibited.

Attendance—Members, 77; Visitors, 9; total, 86.

Erratum.—The plate illustrating Geo. Hoggan, Esqr.'s paper is numbered xiii., instead of xi. The latter number is therefore deficient, whilst there are *two* plates numbered xiii.

PAST PRESIDENTS.

	Elected.
EDWIN LANKESTER, M.D., F.R.S. . .	July, 1875.
ERNEST HART	,, 1866.
ARTHUR E. DURHAM, F.L.S., &c. . .	,, 1867.
,, ,, ,, ...	,, 1868.
PETER LE NEVE FOSTER, M.A. . .	,, 1869.
LIONEL S. BEALE, M.B., F.R.S., &c. . .	,, 1870.
,, ,, ,, ...	,, 1871.
ROBERT BRAITHWAITE, M.D., F.L.S., &c.	,, 1872.
,, ,, ,, ...	,, 1873.

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PLATES

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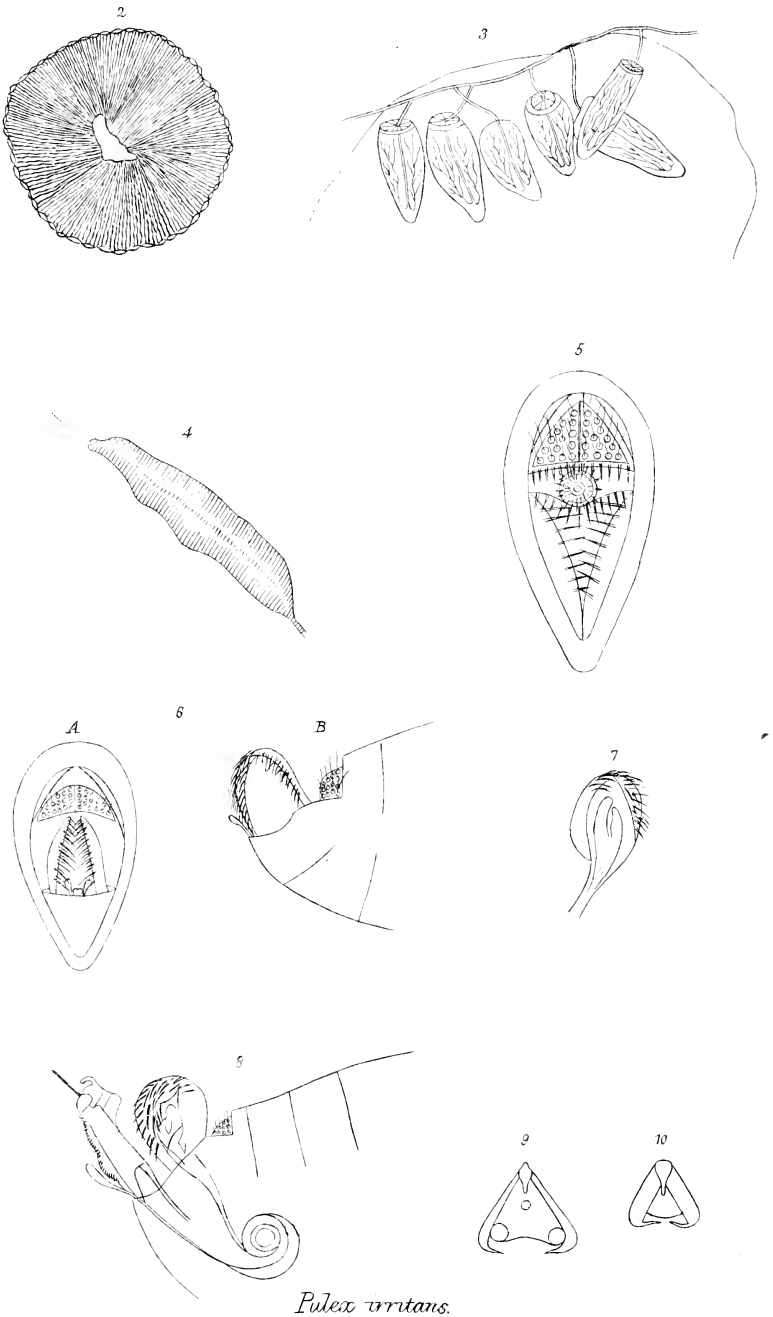
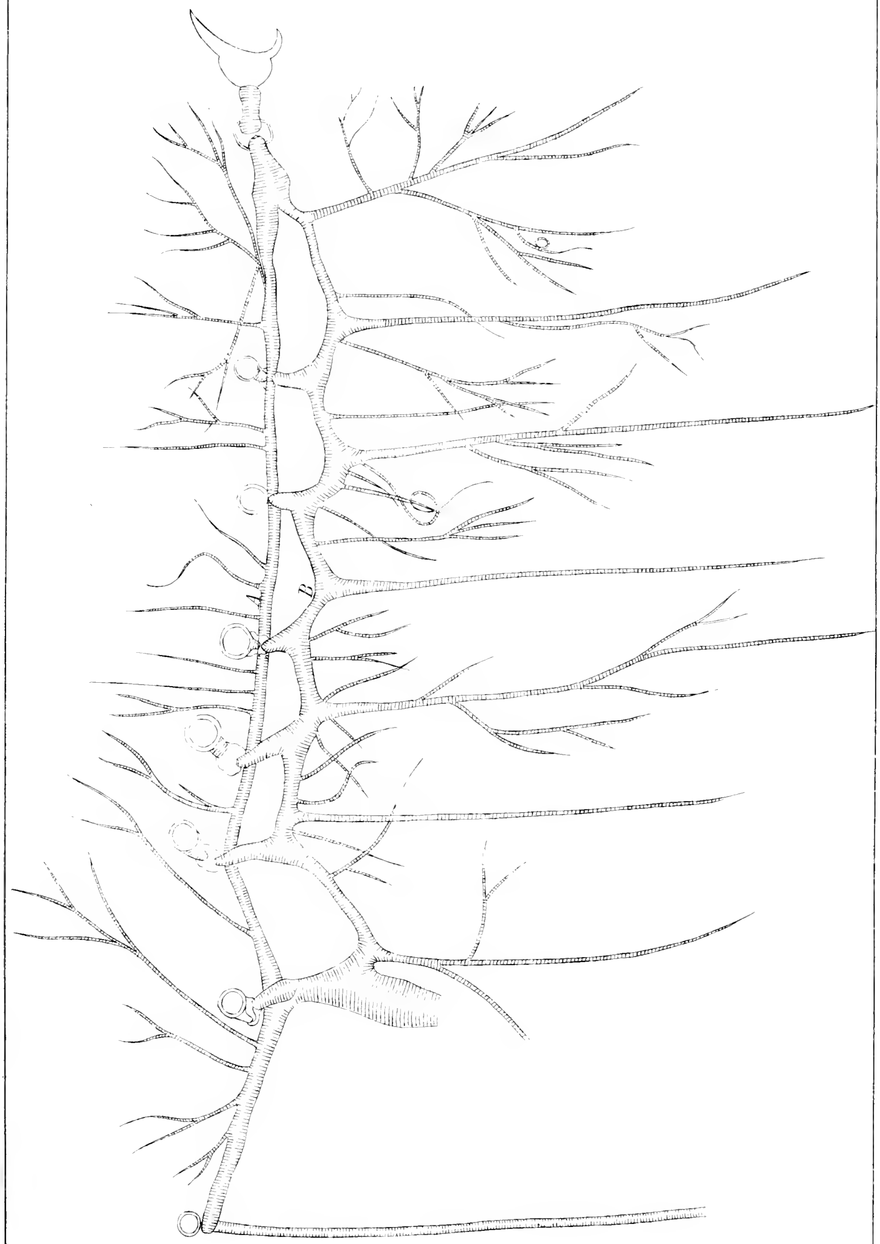


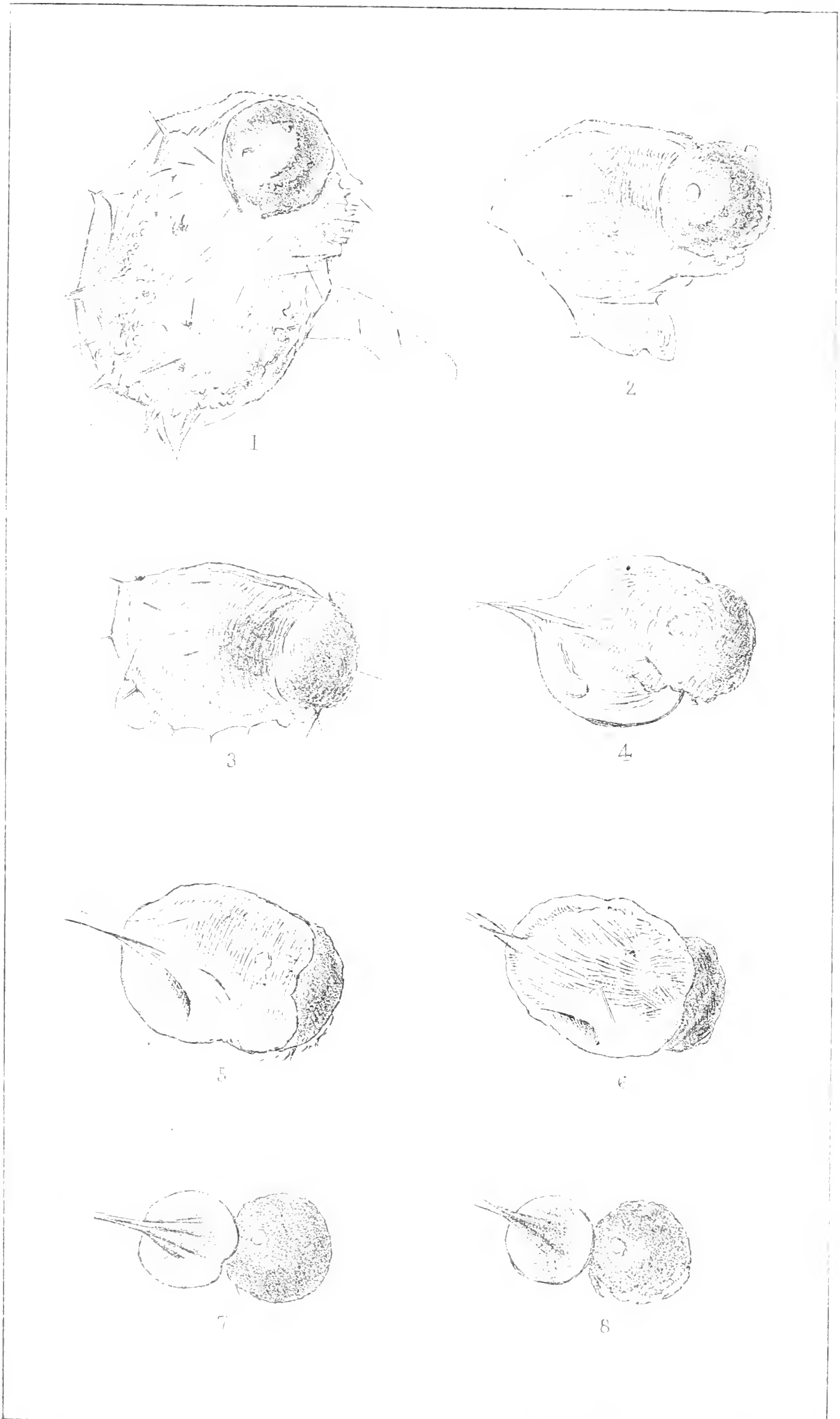
Pulex irritans.

E Cooke, lith.



Pulex irritans.

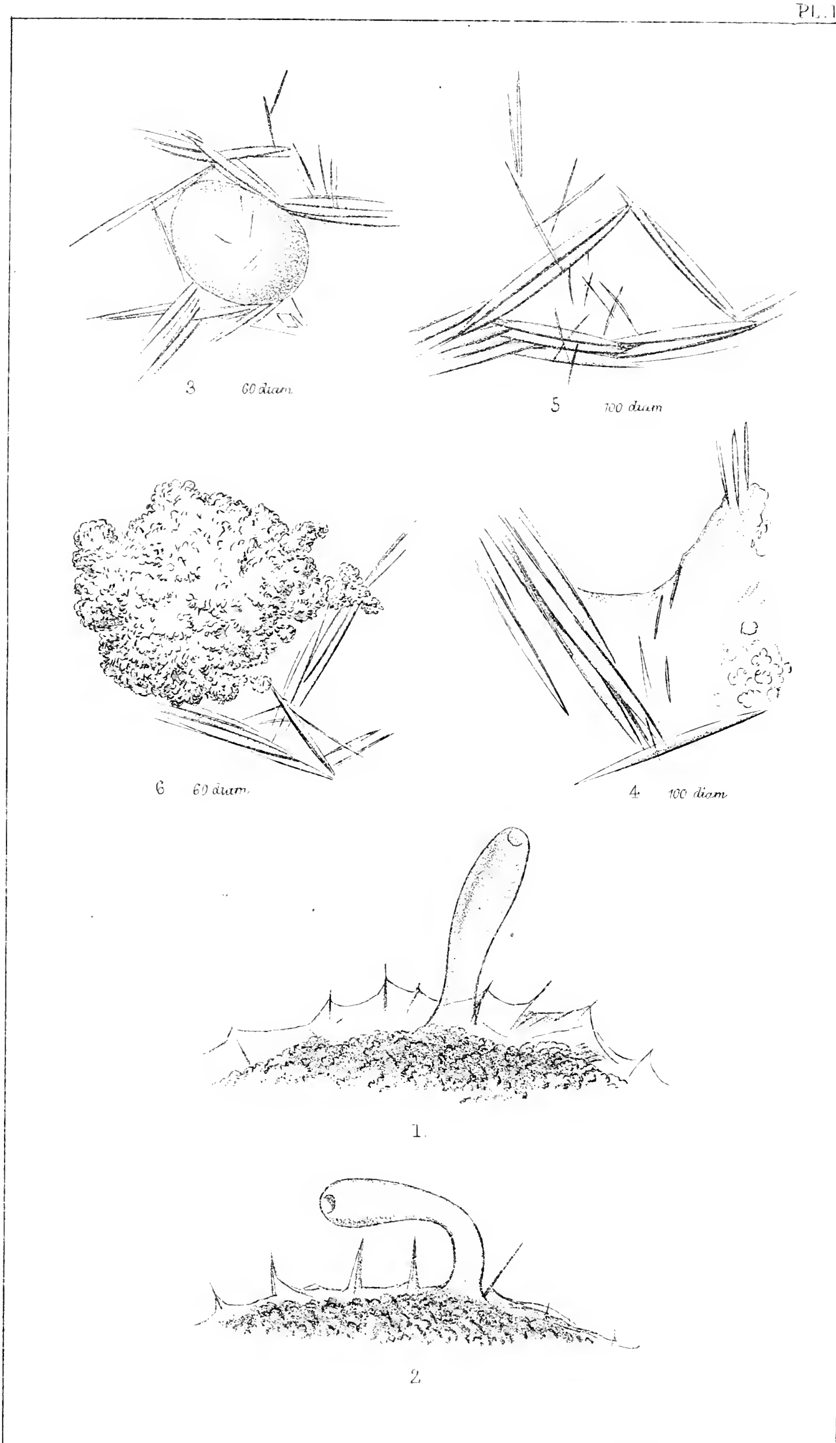
Cooke & Fotheringham lith. Westminster



J. G. W. del.

[illegible] lith Westminster.

SPONGILLA FLUVIATILIS



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Cooke & Fotheringham lith Westminster

SPONGILLA FLUVIATILIS.

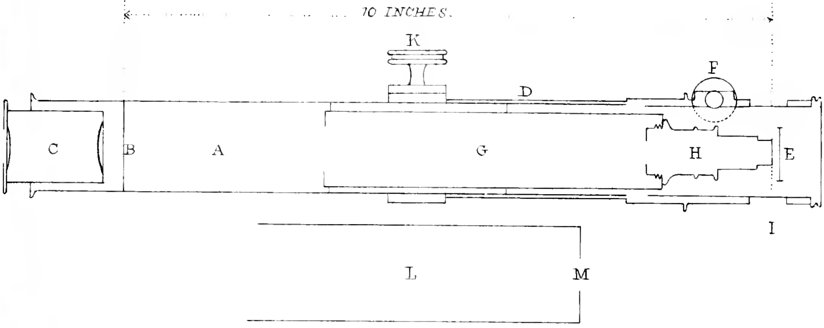


Fig. 1.

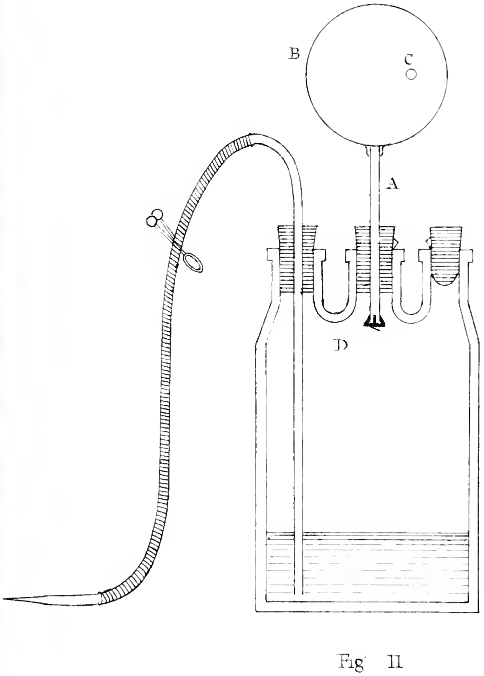


Fig. II

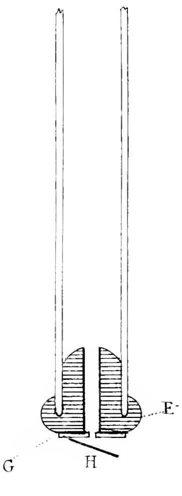


Fig. III.

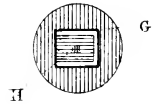
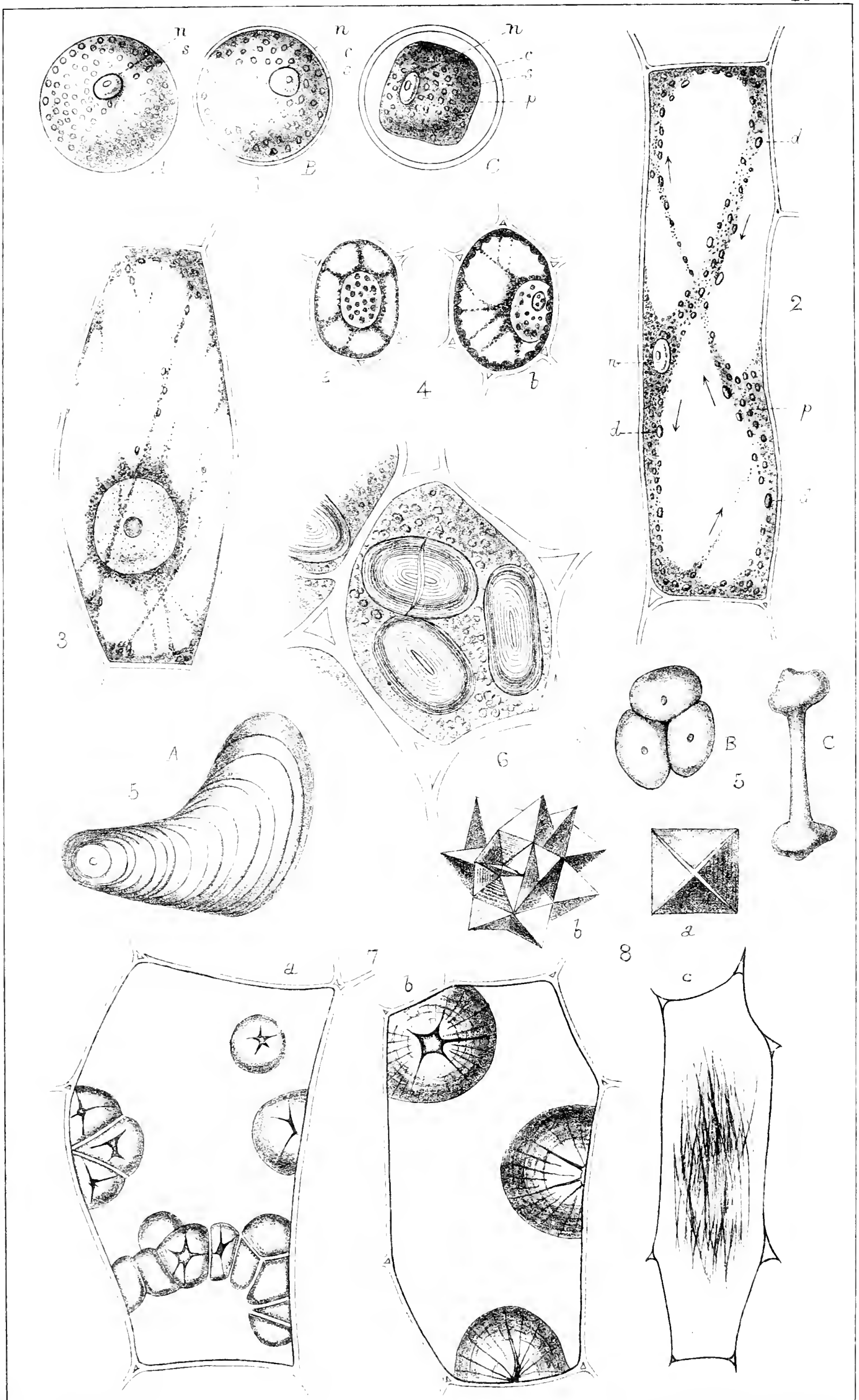
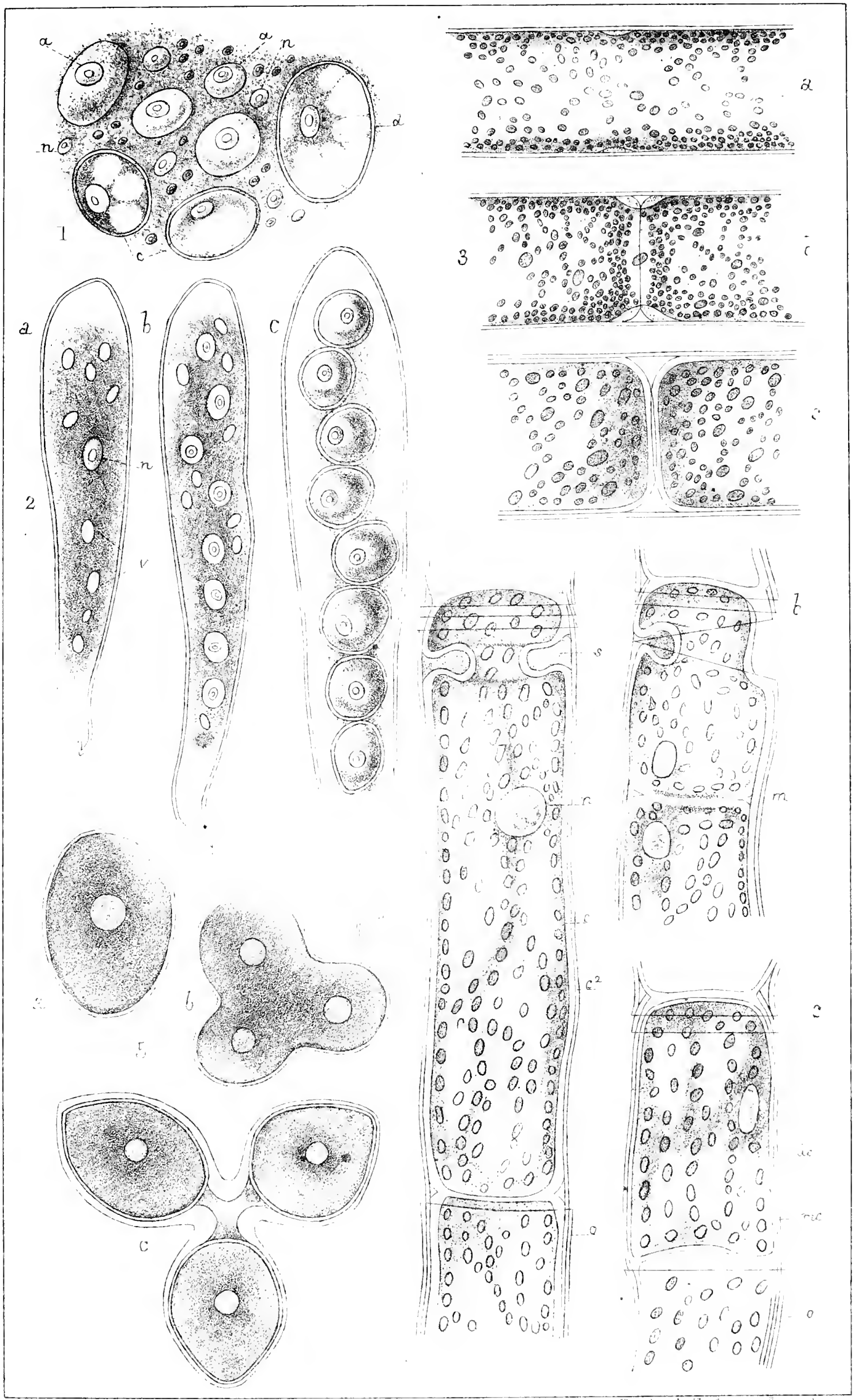


Fig. IV.

Cooke & Fotheringham lith. Westminster

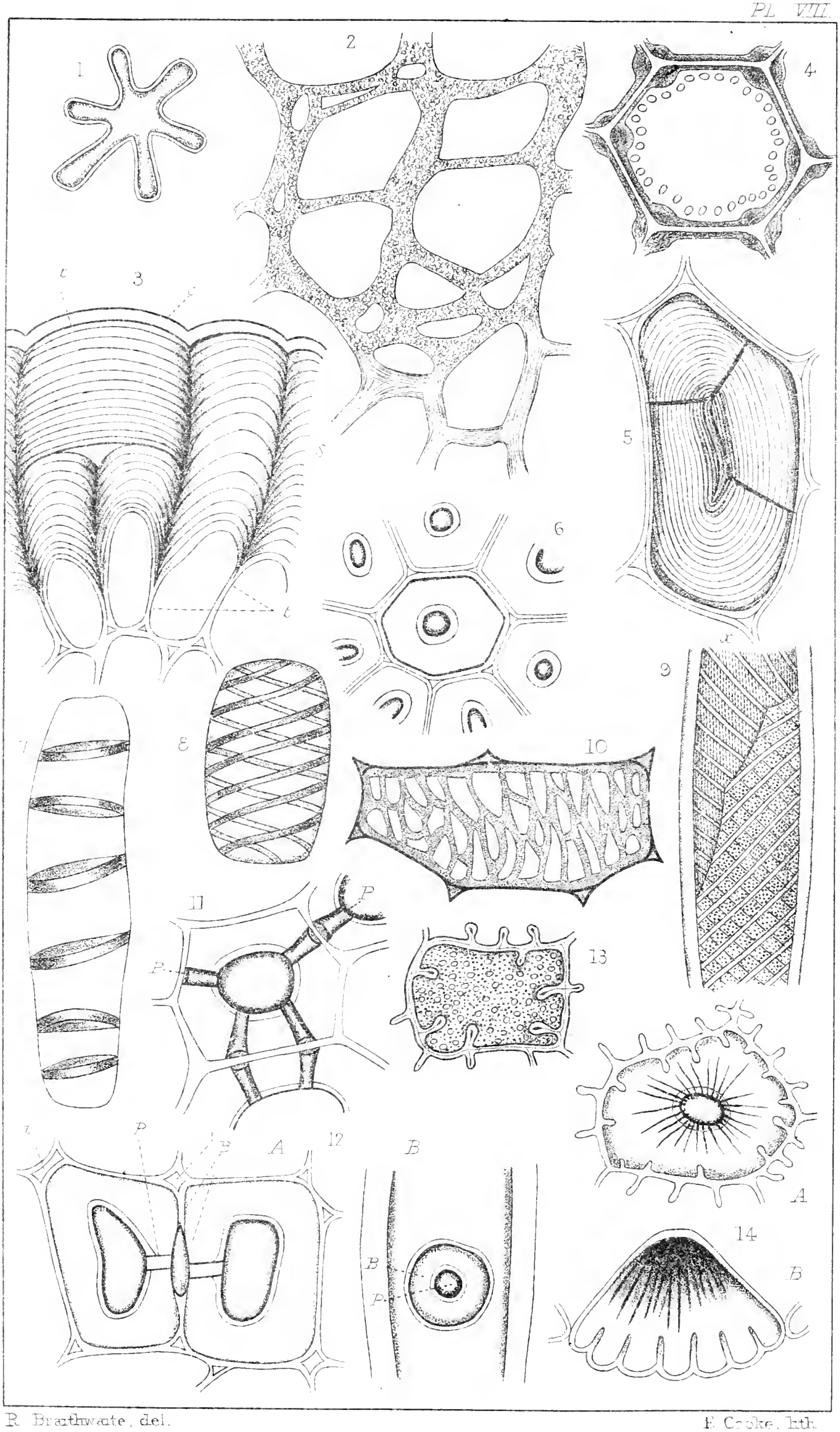


Dr Braithwaite del. Cooke & Fotheringham, lith



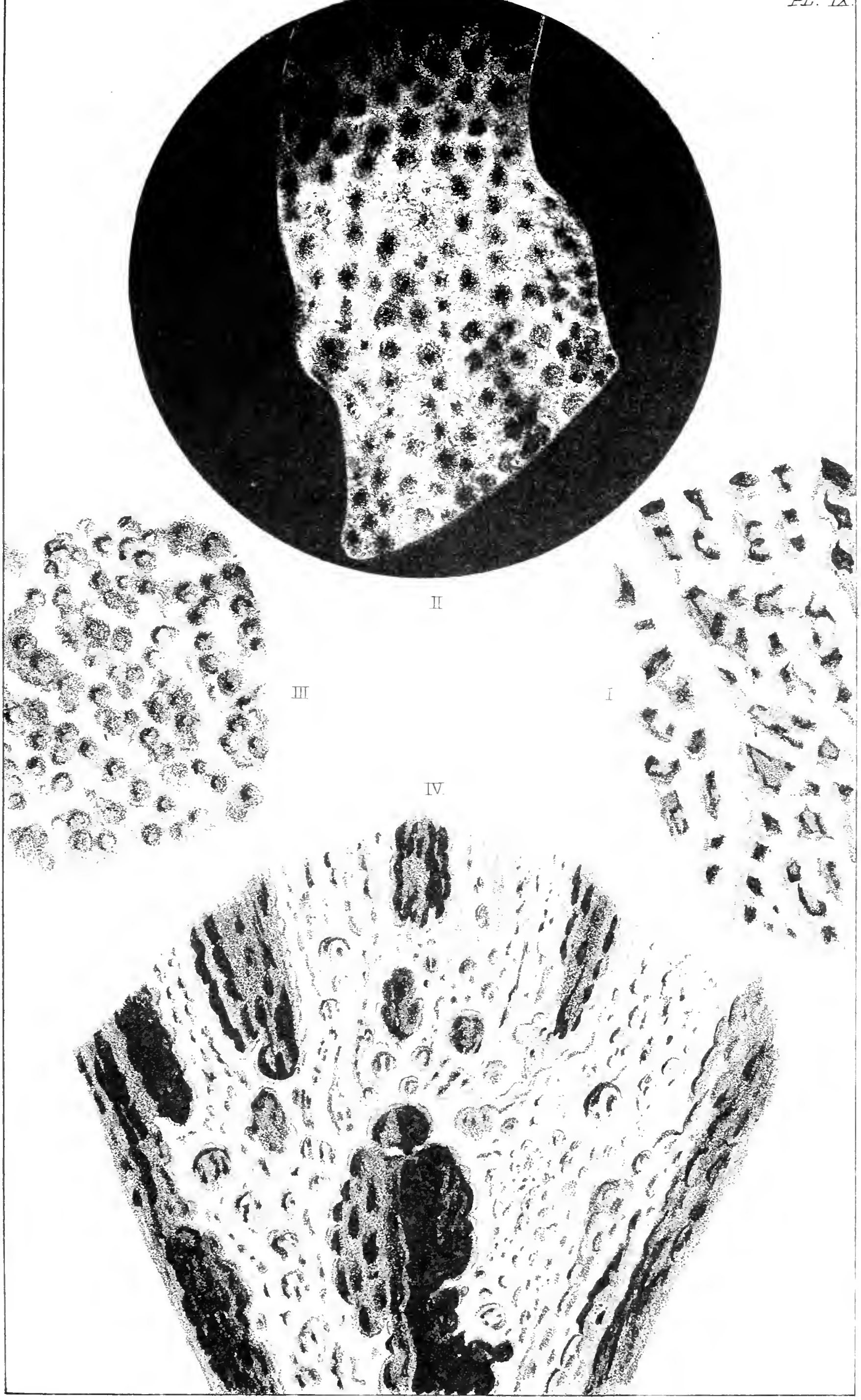
Dr Braithwaite, del

Cooke & Fotheringham, lith

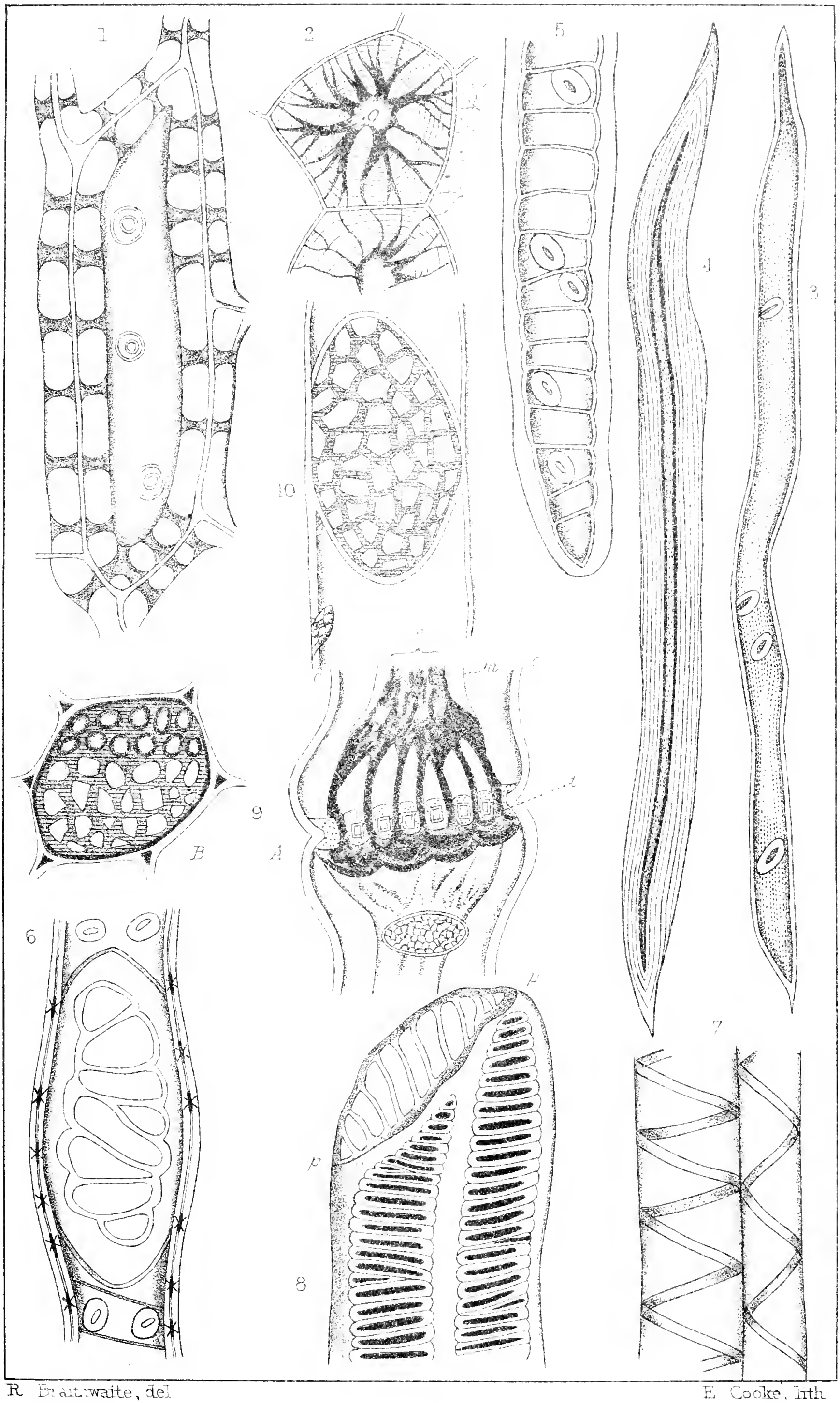


R. Braithwaite, del.

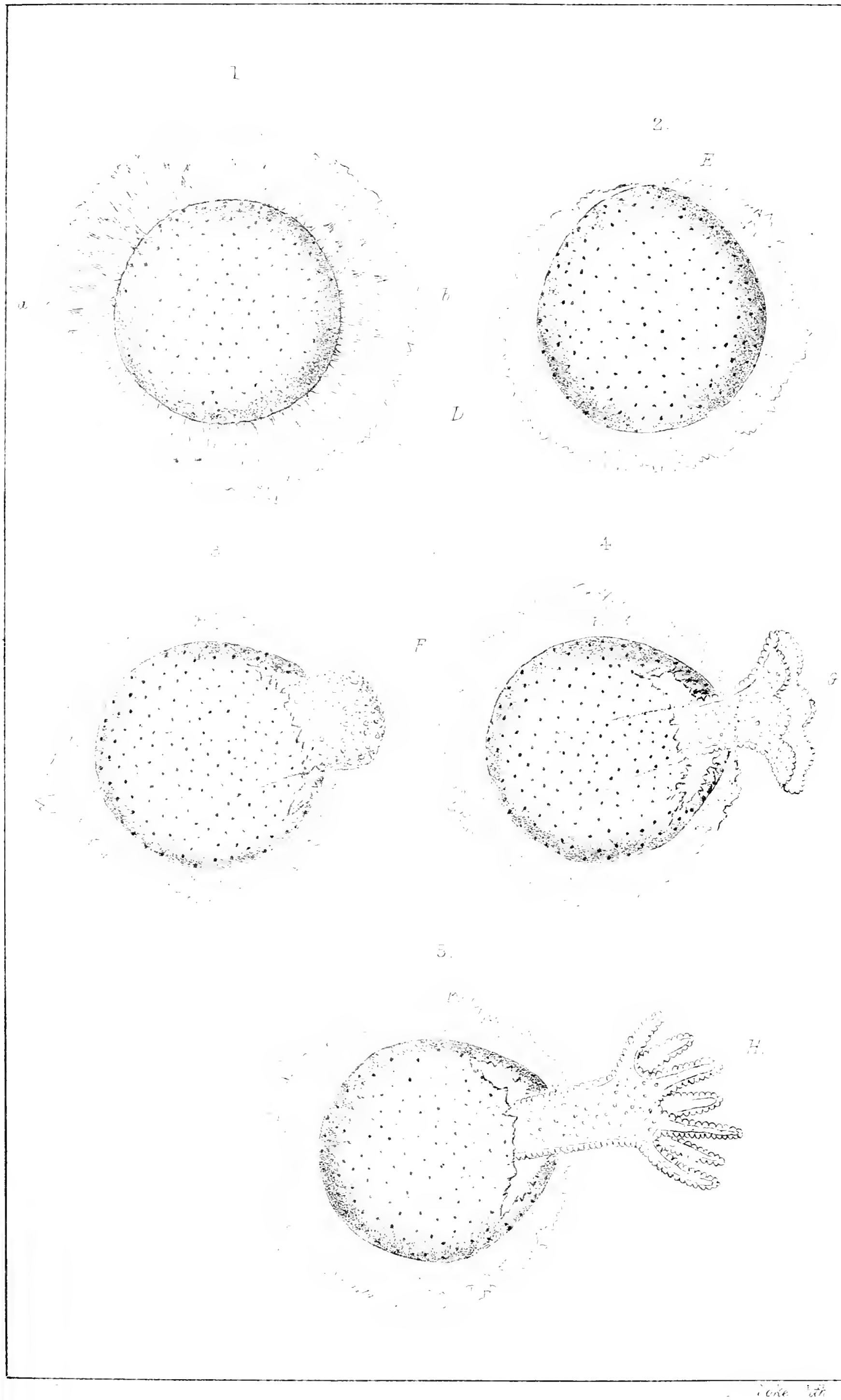
E. Cooke, lith.



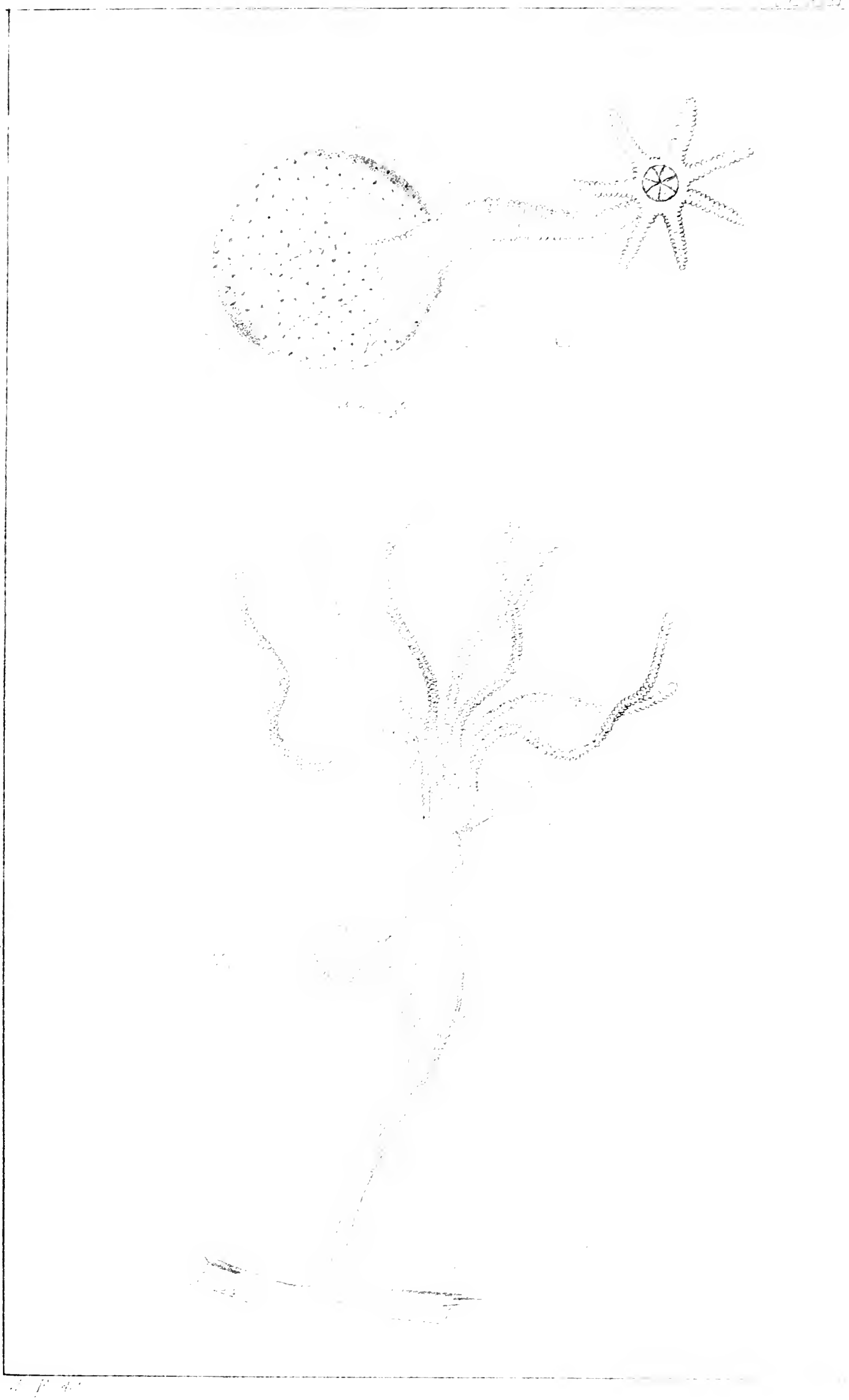
M. H. Johnson, del. E. Cooke lith.

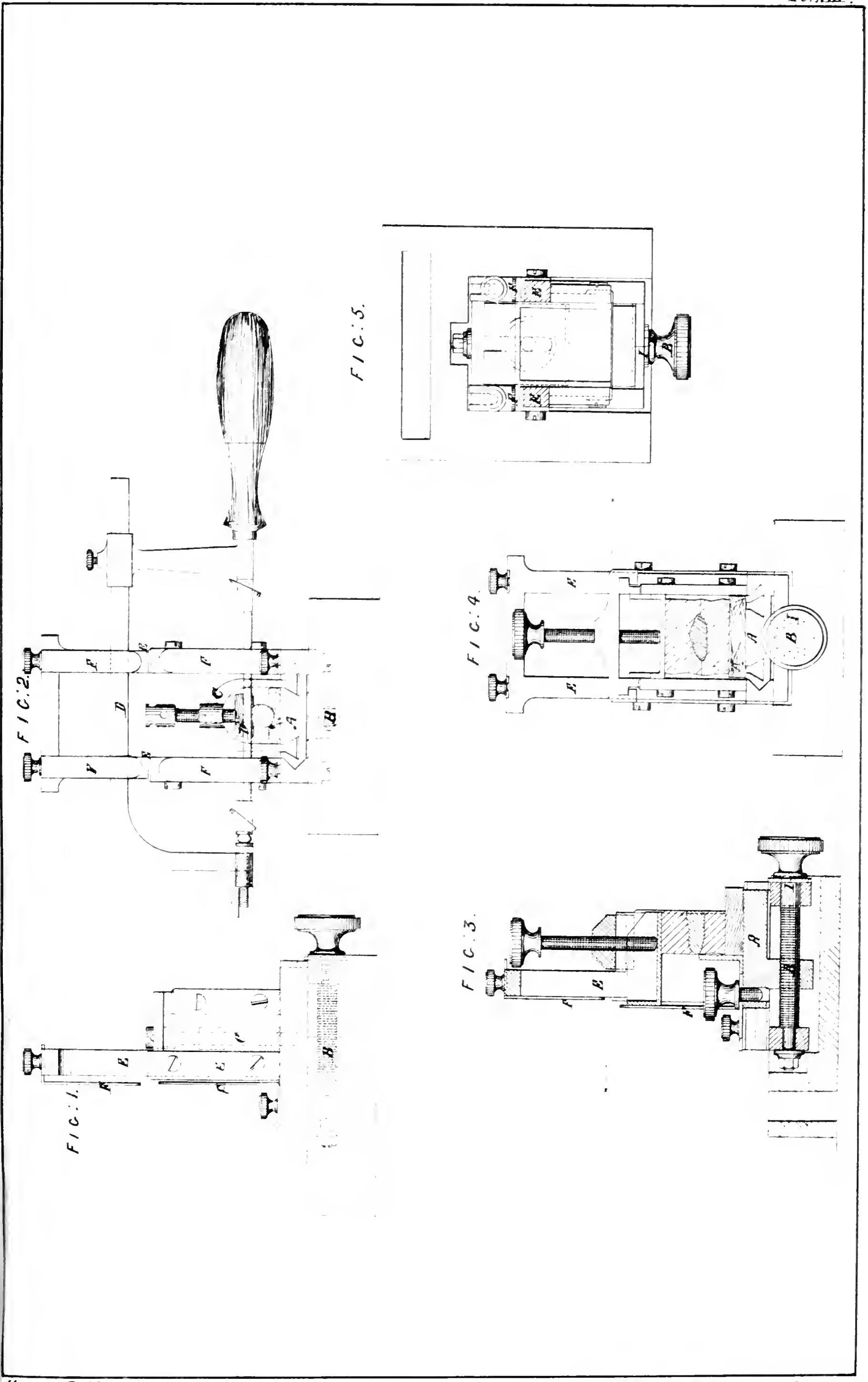


R. Braithwaite, del. E. Cooke, lith.

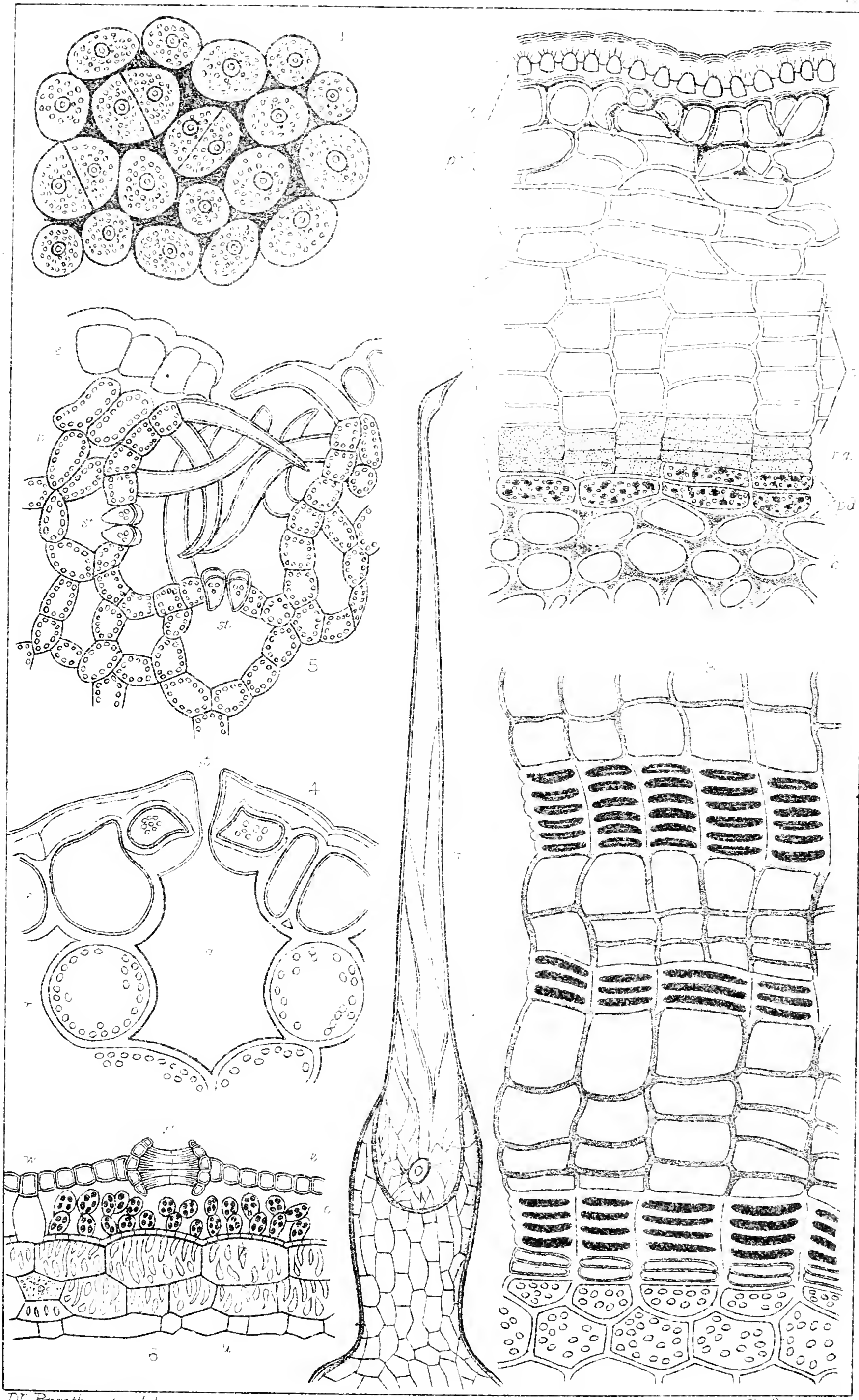


Toke lith



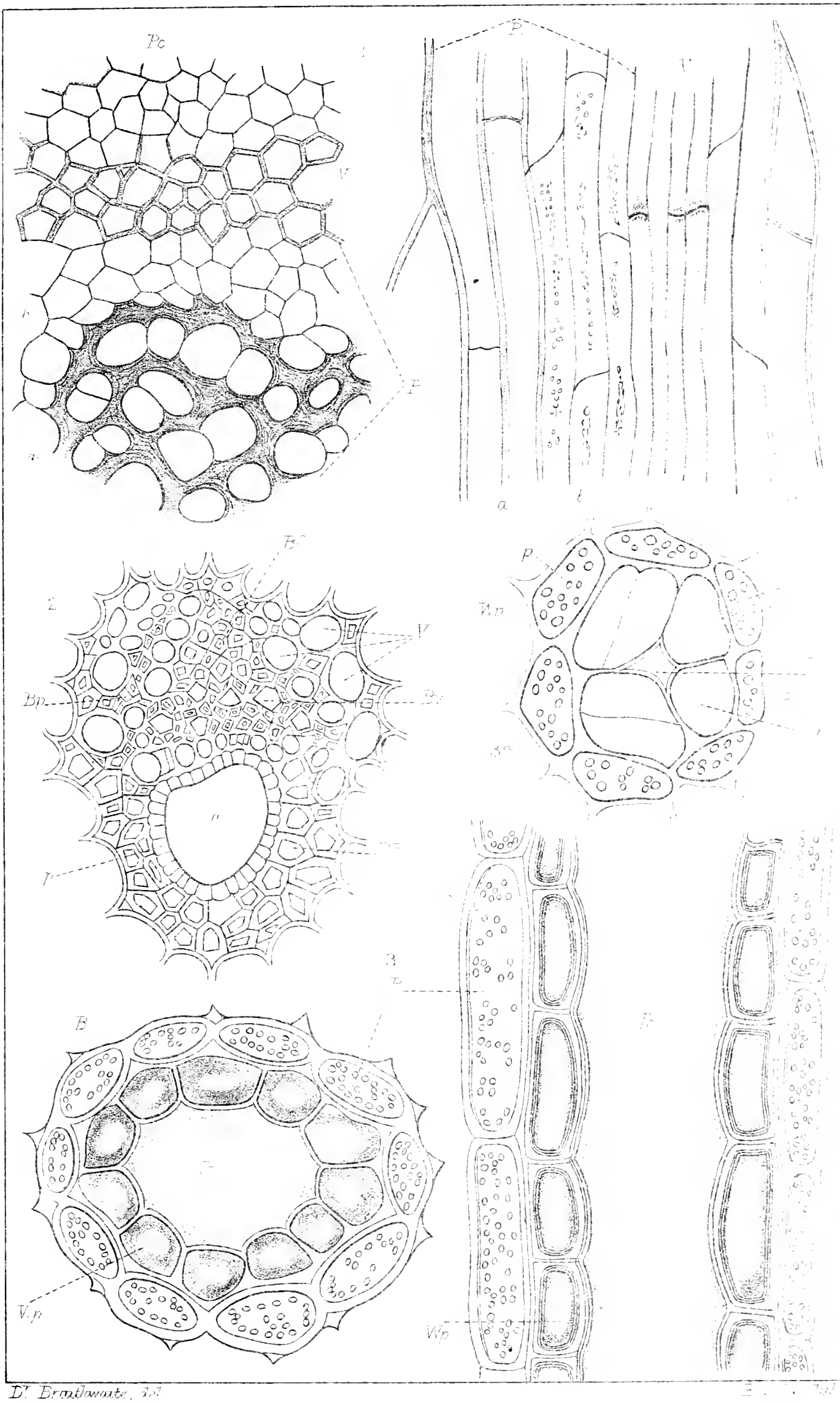


HENRY F. HAILES DELT.



Dr Braithwaite, del.

E. Cooke, lith.



Dr. Braithwaite, del.

CATALOGUE

OF

MICROSCOPICAL PREPARATIONS.

ANIMAL.

Sect. A.—VERTEBRATA.

1. Bimana.

A.		Donor.
1.	Human blood crystals **B**	B. W. Richardson.
2.	,, cerebellum **B**	C. B. Wiles.
3.	,, kidney (section) **B**	B. W. Richardson.
4.	,, lip (,,) **B**	T. Curties.
5.	,, lung **B**	A. Topping.
6.	,, placenta **B**	C. B. Wiles.
7.	,, scalp (section) **B**	T. Curties.
8.	,, scalp (,,) **B**	A. Topping.
9.	,, skin **B**	C. B. Wiles.
10.	,, skin, sole of child's foot **B**	C. B. Wiles.
11.	,, skin, section of Negro's **B**	Mr. Taylor.
12.	,, Do. do. **B**	M. C. Cooke.
13.	,, Do. do. Westminster Abbey **B** ...	H. F. Hailes.
14.	,, tongue **B**	C. B. Wiles.
15.	,, Dental exostosis **B**	T. C. White.

2. Quadrumana.

16.	Hair of *Coluber gueriza* (black)...	H. F. Hailes.
17.	,, Do. do. (white)	H. F. Hailes.
18.	,, Gorilla	Mr. Simson.
19.	,, Marmosette **B**	G. Potter.
20.	,, *Semnopithecus obscurus*...	M. C. Cooke.
21.	,, *Stenops javanicus* **B**	,,
22.	,, *Stenops tardigradus*, Lemur **B**	,,
23.	,, *Galeopithecus volans* (Back) **B** ...	,,
24.	,, ,, ,, (Belly) **B** ...	,,

3. Cheiroptera.

A.			Donor.
25.	Hair of	Australian Bat **B**	G. E. Quick.
26.	„	Long-eared Bat (Cuba)	M. C. Cooke.
27.	„	*Barbastellus communis* "Barbastelle" ...	„
28.	„	*Barbastellus Daubentoni* (Britain) **B** ...	„
29.	„	*Cynopterus brevicaudatus*	„
30.	„	*Cynopterus Horsfieldii* (Java) **B**... ...	„
31.	„	*Cynopterus Horsfieldii* (Java)	„
32.	„	*Cynopterus marginatus* (N. India) **B** ...	„
33.	„	*Cynopterus marginatus* (N. India) ...	„
34.	„	*Cynopterus titthæchilus* (India) **B** ...	„
35.	„	*Cynopterus titthæchilus* (India)	„
36.	„	*Hipposideros armiger* (India) **B**	„
37.	„	*Hipposideros armiger* (India)	„
38.	„	*Hipposideros galeritus*	„
39.	„	*Hipposideros insignis* (Java) **B**	„
40.	„	*Hipposideros insignis* (Java)	„
41.	„	*Hipposideros murinus* (S. India) **B** ...	„
42.	„	*Hipposideros murinus* (S. India)... ...	„
43.	„	*Hipposideros nobilis* (Malacca) **B** ...	„
44.	„	*Hipposideros nobilis* (Malacca)	„
45.	„	*Hipposideros larvatus* (Sylhet) **B** ...	„
46.	„	*Hipposideros larvatus* (Sylhet)	„
47.	„	*Hipposideros tridens* (Mesopotamia) ...	„
48.	„	*Hipposideros vulgaris* (Java) **B**	„
49.	„	*Hipposideros vulgaris* (Java)	„
50.	„	*Hipposideros Rouxii* (India) **B**	„
51.	„	*Hipposideros Rouxii* (India)	„
52.	„	*Kerivoula Hardwickii* (India) **B**... ...	„
53.	„	*Kerivoula Hardwickii* (India)	„
54.	„	*Kerivoula papillosa* (India) **B**	„
55.	„	*Kerivoula papillosa* (India)	„
56.	„	*Kerivoula picta* (N. India) **B**	„
57.	„	*Kerivoula picta* (N. India)	„
58.	„	*Lasiurus cenereus* (Chicago, U.S.) ...	„
59.	„	*Lasiurus intermedius* (Mexico)	„
60.	„	*Lasiurus Noveboracensis* (Tennessee) ...	„
61.	„	*Lasiurus Pearsoni* (N. India) **B**	„
62.	„	*Lasiurus Pearsoni* (N. India)	„
63.	„	*Macroglossus minimus* (Java) **B** ...	„
64.	„	*Macroglossus minimus* (Java)	„
65.	„	*Macrotus Californicus* (California) ...	„
66.	„	*Megaderma lyra* (India) **B**	„
67.	„	*Megaderma lyra* (India)	„
68.	„	*Megaderma spasma* (Malaya) **B**... ...	„
69.	„	*Megaderma spasma* (Malaya)	„
70.	„	*Mormops Blainvillei* (Mexico)	„
71.	„	*Nycteris javanica* (Java) **B**	„
72.	„	*Nycteris javanica* (Java)	„
73.	„	*Nycticejus crepuscularis* (Mexico) ...	„
74.	„	*Nycticejus flaveolus* (India) **B**	„

A.		Donor.
75.	Hair of *Nycticejus flaveolus* (India)	M. C. Cooke.
76.	,, *Nycticejus ornatus* (Himalayas) **B** ...	,,
77.	,, *Nycticejus ornatus* (Himalayas)	,,
78.	,, *Nycticejus Temminckii* (India) **B** ...	,,
79.	,, *Nycticejus Temminckii* (India)	,,
80.	,, *Nyctinomus nasutus* (California)... ...	,,
81.	,, *Nyctinomus tenuis* (India) **B**	,,
82.	,, *Nyctinomus plicutus* (Java)	,,
83.	,, *Plecotus auritus* (Britain)	,,
84.	,, *Plecotus Darjelingensis* (Sikkim) **B** ...	,,
85.	,, *Plecotus Darjelingensis* (Sikkim) ...	,,
86.	,, *Plecotus homochrous* (S. India) **B** ...	,,
87.	,, *Plecotus homochrous* (S. India)	,,
88.	,, *Pteropus edulis* (Bengal) **B**	,,
89.	,, *Pteropus edulis* (Bengal)	,,
90.	,, *Pteropus Edwardsii* (India) **B**	,,
91.	,, *Pteropus Edwardsii* (India)	,,
92.	,, *Pteropus poliocephalus* (New Holland) **B**	,,
93.	,, *Pteropus poliocephalus* (New Holland) ...	,,
94.	,, *Rhinolophus affinis* (Malaya) **B**	,,
95.	,, *Rhinolophus affinis* (Malaya)	,,
96.	,, *Rhinolophus hipposideros* (Britain) ...	,,
97.	,, *Rhinolophus luctus*	,,
98.	,, *Rhinolophus minor* (India) **B**	,,
99.	,, *Rhinolophus minor* (Java)	,,
100.	,, *Rhinolophus murinus* **B**	,,
101.	,, *Rhinolophus Pearsonii* (Sikkim) **B** ...	,,
102.	,, *Rhinolophus Pearsonii* (Sikkim)... ...	,,
103.	,, *Rhinolophus perniger* (India) **B**	,,
104.	,, *Rhinolophus perniger* (India)	,,
105.	,, *Rhinolophus tragatus* (N. India) **B** ...	,,
106.	,, *Rhinolophus tragatus* (N. India) ...	,,
107.	,, *Rhinopoma Hardwickii* (India) **B** ...	,,
108.	,, *Rhinopoma Hardwickii* (India)	,,
109.	,, *Rhinopoma microphylla* (Egypt) **B** ...	,,
110.	,, *Rhinopoma microphylla* (Egypt) ...	,,
111.	,, *Scotophilus Carolinensis* (Nebraska) ...	,,
112.	,, *Scotophilus Coromandelinus* (S. India) **B**	,,
113.	,, *Scotophilus Coromandelinus* (S. India) ...	,,
114.	,, *Scotophilus Georgianus* (Pennsylvania) ...	,,
115.	,, *Scotophilus fuscus* (Nebraska)	,,
116.	,, *Scotophilus lobatus* (W. India) **B** ...	,,
117.	,, *Scotophilus lobatus* (W. India)	,,
118.	,, *Scotophilus Maderaspatensis* (S. India) **B**	,,
119.	,, *Scotophilus Maderaspatensis* (S. India) ...	,,
120.	,, *Scotophilus noctivagans* (Nebraska) ...	,,
121.	,, *Scotophilus Temminckii* (Penang) ...	,,
122.	,, *Taphozous longimanus* (India) **B** ...	,,
123.	,, *Taphozous longimanus* (India)	,,
124.	,, *Taphozous melanopogon* (India) **B** ...	,
125.	,, *Taphozous melanopogon* (India)	,,

A.		Donor.
126.	Hair of *Taphozous saccolaimus* (Java)	M. C. Cooke.
127.	,, *Vespertilio adversus* (Java) **B**	,,
128.	,, *Vespertilio adversus* (Java)	,,
129.	,, *Vespertilio blepotis* (Timor)	,,
130.	,, *Vespertilio imbricatus* (Java) **B**... ...	,,
131.	,, *Vespertilio imbricatus* (Java)	,,
132.	,, *Vespertilio lucifugus* (California) ...	,,
133.	,, *Vespertilio mysticinus* (Britain)	,,
134.	,, *Vespertilio Natterii* (Britain)	,,
135.	,, *Vespertilio nitens* (California)	,,
136.	,, *Vespertilio Noveboracensis* (U. States) ...	,,
137.	,, *Vespertilio subulatus* (Michigan) ...	,,
138.	,, *Vespertilio tralititius* (India) **B**	,,
139.	,, *Vespertilio tralititius* (India)	,,
140.	Membrane of Batwing, *Scotophilus lobatus*, **B** ...	,,

4. Insectivora.

141.	Hair of *Erinaceus collaris* (India) **B**	M. C. Cooke.
142.	,, *Erinaceus collaris* (India)	,,
143.	,, *Sorex cærulescens* (India) **B**	,,
144.	,, *Sorex cærulescens* (India)	,,
145.	,, *Sorex murinus* (India) **B**	,,
146.	,, *Sorex murinus* (India)	,,
147-8.	,, *Talpa Europœa*, Mole	G. E. Quick.
149.	,, *Talpa Europœa*, Mole	S. J. McIntire.
150.	,, *Talpa Europœa*, Mole	W. H. Goddard.
151.	,, *Talpa Europœa*, Cream-coloured Mole ...	M. C. Cooke.
152.	,, *Talpa micrura* (India) **B**	,,
153.	,, *Talpa micrura* (India)	,,
154.	,, *Tupaia ferruginea* (India) **B**	,,
155.	,, *Tupaia ferruginea* (India)	,,
156.	Lip of *Erinaceus Europœus*, Hedgehog **B** ...	T. Curties.

5. Carnivora.

157.	Hair of *Aonyx indigitatus*, "Mepal Otter" **B** ...	M. C. Cooke.
158.	,, *Enhydra lutris*, Sea Otter **B**	W. H. Goddard.
159.	,, *Felis leo*, Lion **B**	,,
160.	,, ,, Lion **B**	T. Russell.
161.	,, ,, Lion **B**	C. Bennett, jun.
162, 163.	,, *Felis leopardus*, Leopard **B**	G. E. Quick.
164.	,, ,, ,, Leopard **B**	T. Russell.
165.	,, *Felis pardus*, Panther **B**	G. E. Quick.
166.	,, *Felis tigris*, "Bengal Tiger" **B** ...	W. H. Goddard.
167.	,, *Gymnura Rafflesii* (Malacca) **B**... ...	M. C. Cooke.
168.	,, *Gymnura Rafflesii* (Malacca)	,,
169.	,, *Lutra vulgaris*, "Otter" **B**	,,
170.	,, *Mustela canigula* (India) **B**	,,
171.	,, *Mustela erminea*, "Stoat" **B**	,,
172.	,, ,, Ermine (dry)	W. Hislop.
173.	,, ,, ,, (Spirits) ...	,,
174.	,, ,, ,, (Balsam) ...	,,
175.	,, ,, Ermine	C. J. Breeze.

A.		*Donor.*
176.	Hair of MUSTELA (*leucopus?*) Sable (Dry) ...	W. Hislop.
177.	,, ,, Sable (Spirits) ...	,,
178.	,, ,, Sable (Balsam) ...	,,
179.	,, ,, Sable **B**	H. F. Hailes.
180.	,, ,, ,, **B**	G. E. Quick.
181.	,, *Mustela putorius* "Polecat" **B**	M. C. Cooke.
182.	,, ,, Fitchet (Dry) ...	W. Hislop.
183.	,, ,, ,, (Spirits) ...	,,
184.	,, ,, ,, (Balsam) ...	,,
185.	,, *Mustela vulgaris*, Weasel **B**	T. Russell.
186.	,, *Mustela martes*, Weasel **B**	M. C. Cooke.
187.	,, Stone marten	W. W. Reeves.
188.	,, *Paradoxurus Derbyanus* (India) **B** ...	M. C. Cooke.
189.	,, *Procyon lotor*, Racoon	W. W. Reeves.
190.	,, *Procyon lotor*, Racoon **B**	H. F. Hailes.
191.	,, *Taxus meles*, Badger (Dry)	W. Hislop.
192.	,, ,, ,, (Spirits)	,,
193.	,, ,, ,, (Balsam)	,,
194.	,, *Thalarctos maritimus*, Polar bear **B** ...	T. Russell.
195.	,, *Ursus arctos*, Brown Bear **B**	,,
196.	,, *Ursus Americanus*, Bear	W. W. Reeves.
197.	,, *Vison lutreola*, Mink	C. J. Breeze.
198.	,, *Vison lutreola*, Mink	W. W. Reeves.
199.	,, *Viverra Zibetha*, Civet **B**	M. C. Cooke.
200.	,, *Vulpes Bengalensis* (Bengal) **B**	,,
201.	,, *Vulpes flavescens* (Candahar) **B**... ...	,,
202.	,, *Vulpes vulgaris*, Fox **B**...	,,
203.	,, *Vulpes vulgaris*, Fox **B**	G. E. Quick.
204.	Tongue of Cat (injected) **B**	A. Topping.

6. AMPHIBIA.

205.	Hair of *Arctocephalus Falklandicus* (Falkland Isles) **B**	M. C. Cooke.
206.	,, *Otaria Falklandica* (New Zealand) **B** ...	,,
207.	,, *Otaria Falklandica* (Falkland Isles) **B** ...	,,
208.	,, *OtariaFalklandica* (Cape of Good Hope) **B**	,,
209.	,, Yellow Seal **B**	
210.	,, Dark Brown Seal	G. Potter.
211.	,, Seal	C. J. Breeze.
212.	,, Seal **B**	H. F. Hailes.
213.	,, Seal	,,
214.	,, Seal **B**	T. Russell.
215.	,, Seal **B**	G. E. Quick.

7. MARSUPIALIA.

216.	Hair of *Pterogale xanthopus*, Kangaroo **B** ...	T. Russell.
217.	,, Opossum **B**	G. E. Quick.

8. RODENTIA.

218.	Hair of *Alactaga Indica* (Affghanistan) **B** ...	M. C. Cooke.
219.	,, *Alactaga Indica* (Affghanistan) ...	,,
220.	,, *Castor fiber*, Beaver **B**	H. F. Hailes.

A.		Donor.
221.	Hair of *Castor fiber*, Beaver **B**	M. C. Cooke.
222.	„ *Chinchilla laniger*, Chinchilla	W. W. Reeves.
223.	„ *Fiber zibethinus*, Musquash **B**	M. C. Cooke.
224.	„ *Gerbillus erythrurus* (N. W. India) **B**	„
225.	„ *Gerbillus erythrurus* (N. W. India)	„
226, 227.	„ *Lepus timidus*, Hare	„
228.	„ *Mus decumanus*, Norway Rat **B**	„
229.	„ *Mus decumanus*, Norway Rat	„
230.	„ *Mus dubius* (Nepal.) **B**	„
231.	„ *Mus dubius* (Nepal.)	„
232.	„ *Mus setifer* (Java) **B**	„
233.	„ *Mus setifer* (Java)	„
234.	„ *Mus musculus*, Mouse **B**	E. Marks.
235.	„ *Myopotamus coypus*, Coypu **B**	M. C. Cooke.
236.	„ *Pteromys magnifica* (Nepal.)	„
237.	„ *Pteromys magnifica* (Nepal.) **B**	„
238.	„ *Pteromys melanotis* (Siam) **B**	„
239.	„ *Pteromys melanotis* (Siam)	„
240.	„ *Sciurus chinensis* (China) **B**	„
241.	„ *Sciurus Europæus*, Squirrel	W. W. Reeves.
242.	„ *Sciurus Maclellandi* (Assam) **B**	M. C. Cooke.
243.	„ *Sciurus penicellatus* (Madras) **B**	„
244.	„ *Sciurus Lokriah* (Nepal.) **B**	„
245.	„ *Sciurus vulgaris*, Squirrel **B**	„
246.	„ Black Rabbit **B**	„
247.	„ Silver Rabbit **B**	G. E. Quick.
248, 249.	„ „ „ **B**	G. E. Quick.
250.	„ Silver Grey Rabbit **B**	C. J. Breeze.
251.	„ White Rabbit	„
252.	„ Rat **B**	G. E. Quick.
253.	Section of Porcupine Quill. **B**	T. Curties.

9. Edentata.

254.	Hair of *Ornithorhynchus paradoxus*. **B**	W. W. Reeves.

10. Pachydermata.

255.	Bone of Rhinoceros. Fossil. **B**	A. Topping.
256.	Hair of *Elephas indicus*, Elephant (section) **B**	W. H. Goddard.
257.	„ „ (section) **B**	G. Potter.
258.	„ „ Peccary (section) **B**	T. Russell.
259.	Hoof of Horse (section) **B**	A. Topping.
260.	„ Horse **B**	M. C. Cooke.
261.	„ Pig **B**	A. Topping.
262,263.	Horn of Rhinoceros (sections) **B**	G. E. Quick.

11. Ruminantia.

264.	Blood Crystals of Sheep	B. W. Richardson.
265.	Hair of *Auchenia pachos*, Alpaca **B**	T. Russell.
266.	„ *Auchenia huanaco*, Huanaco **B**	„
267.	„ *Camelus dromedarius* (Sindh.)	M. C. Cooke.
268.	„ *Catoblechas gorgon*, Gnu **B**	T. Russell.

A.		Donor.
269.	Hair of Goat **B**	W. H. Goddard.
270.	„ Kolmsky Hair **B**	„
271.	„ Mantchurian Deer **B**	C. Bennett, jun.
272,273.	„ Mexican Deer **B**	G. E. Quick.
274.	„ *Moschus Ranchil* **B**	M. C. Cooke.
275.	„ Musk (Dry)	W. Hislop.
276.	„ „ (Spirits)	„
277.	„ „ (Balsam)	„
278.	„ *Ovis ammon* Argali **B**	M. C. Cooke.
279.	„ Reindeer **B**	T. Russell.
280.	„ Reindeer **B**	G. Potter.
281.	Liver of Sheep **B**	T. Curties.
282.	Stag's horn (longitudinal) **B**	T. C. White.
283.	Stag's horn (transverse) **B**	„

12. CETACEA.

284.	Dugong Bone. Fossil (transv. sect.)	A. Topping.

13. AVES.

285.	Blood crystals of Chicken **B**	B. W. Richardson.
286.	Feathers of *Anas boschas* Duck Down. **B** ...	M. C. Cooke.
287.	„ *Cuculus cupreus* (India)	„
288.	„ *Lophophorus Impeyanus* (India) ...	„
289.	„ *Meleagris gallopavo* Turkey Down. **B**	„
290.	„ *Pavo cristatus*, Peacock	„
291.	„ *Pavo cristatus*, Peacock	„
292.	„ *Phasianus colchicus*, Pheasant Down.	„
293.	„ *Polyplectus Hardwickii* (India) ...	„
294.	„ *Somateria mollissima*, Eider Down.	„
295, 296	„ *Trochilus furcatus* (Brazil)	„

14. REPTILIA.

297, 298.	Anatomy of Tadpole	J. A. Archer.

15. PISCES.

299.	Fossil Fish Tooth, Lower Coal Measures (Northumberland.) **B**	T. Russell.
300.	„ „ „ (Lancashire.) **B**	„
301.	„ Fish Bone **B** „	„
302.	Gill of sword fish, *Xiphias gladius*	M. C. Cooke.
303.	„ epiderm **B**	„
304.	Periosteum bone of skate	G. Paton.
305.	Scales of *Acerina vulgaris*, Pope	M. C. Cooke.
306.	„ *Abramis brama*, Bream...	„
307.	„ *Anguilla acutirostris*, Eel	G. E. Quick.
308.	„ „ *mediorostris*, Snig eel	M. C. Cooke.
309.	„ *Clupea sprattus*, Sprat	„
310.	„ *Cyprinus auratus*, Gold fish	W. H. Golding.
311.	„ *Cyprinus carpio*, Carp	„
312.	„ „ *cephalus*, Chub	M. C. Cooke.
313.	„ „ *carassius*, Crucian	„
314.	„ „ *erythrophthalmus*, Rudd ...	„
315.	„ „ *Gibelio*, Prussian carp... ...	„

A.		Donor.
316.	Scales of *Esox lucius*, Pike	W. H. Golding.
317.	„ *Exocœtus volitans*, Flying Fish **B**	G. E. Quick.
318.	„ *Gobio fluviatilis*, Gudgeon	M. C. Cooke.
319.	„ *Leuciscus alburnus*, Bleak	„
320.	„ „ *rutilus*, Roach	W. H. Golding.
321.	„ „ *vulgaris*, Dace **B**	E. Marks.
322, 323.	„ *Mullus ruber*, Red Mullet **B**	G. E. Quick.
324.	„ *Perca fluviatilis*, Perch **B**	E. Marks.
325.	„ *Rhombus maximus*, Turbot **B**	T. C. White.
326.	„ *Salmo salar*, Salmon	M. C. Cooke.
327.	„ „	W. H. Golding.
328.	„ *Salmo trutta*, Trout	M. C. Cooke.
329.	„ *Solea vulgaris*, Sole Skin.	E. Marks.
330.	„ *Tinca vulgaris*, Tench	M. C. Cooke.
331,332.	Sea Horse, *Hippocampus brevirostris*	G. H. King.
333,334.	„ *Hippocampus ramulosus*	„
335.	Section of Saw fish **B**	A. F. Pickard.
336.	„ Shark's tooth **B**	T. C. White.

Sect. B.—INVERTEBRATA.

1. Mollusca.

B		Donor.
1.	Cilia of *Terebratula caput serpentis* **B**	J. Slade.
2.	Mantle of *Terebratula caput serpentis* **B**	„
3, 4.	Palate of *Buccinum undatum*, Whelk	G. E. Quick.
5.	„ *Buccinum* **B**	„
6.	„ *Buccinum undatum*, Whelk	G. Paton.
7.	„ *Chiton* **B**	H. F. Hailes.
8, 9.	„ *Haliotis tuberculata*, Ear shell	Dr. Dempsey.
10.	„ *Helix*, Snail **B**	T. Curties.
11.	„ *Littorina littoralis*, Periwinkle	G. E. Quick.
12, 13.	„ *Nassa reticulata*	Dr. Dempsey.
14, 15.	„ *Patella vulgata*, Limpet...	„
16, 17.	„ *Trochus*	„
18.	„ *Testacella haliotoides* **B**...	H. F. Hailes.
19.	„ Section of Pearl **B**	T. Curties.
20.	Shell from Melbourne **B**	T. C. White.
21.	Shell of *Helix exigua* (N. America)	M. C. Cooke.
22.	„ *Helix ferrea* (N. America)	„
23.	„ *Terebratula Australis* **B**...	J. Slade.
24.	„ *Terebratula* (section) **B**...	G. Paton.
25.	„ *Terebratula caput serpentis* **B**	J. Slade.

2. Polyzoa.

26	Chalk Polyzoa, *Pustulopora*	
27.	Crag Polyzoa, *Eschara pertusa*	M. C. Cooke.
28.	„ *Eschara porosa*	„

B.			Donor.
29.	Crag Polyzoa, *Eschara monilifera*	... ...	M. C. Cooke.
30, 31.	„ *Flustra dubia* ...	... ...	„
32.	„ *Meliccrita Charlesworthii*	... ...	„
33.	„ *Retepora simplex*	... ...	„
34.	„ *Salicornaria sinuosa*	... ...	„
35.	Polypary of *Anguinaria spathulata*	... ...	Mr. Waller.
36.	„ *Anguinaria spathulata*...	... ...	M. C. Cooke.
37.	„ *Bugula flabellata*	... ...	„
38.	„ *Bugula Murrayana*	... ...	„
39.	„ *Bugula plumosa*	... ...	„
40.	„ *Canda arachnoidea*	... ...	„
41.	„ *Cellularia avicularia*	... ...	W. Hainworth.
42.	„ *Crisia eburnea*	... ...	G. Paton.
43.	„ *Cellularia reptans*	... ...	M. C. Cooke.
44.	„ *Crisidia cornuta*	... ...	„
45.	„ *Eschara foliacea*	... ...	„
46.	„ *Flustra chartacea*	... ...	„
47.	„ *Flustra foliacea*	... ...	„
48.	„ *Flustra foliacea*	... ...	Mr. Golding.
49.	„ *Flustra membranacea*	... ...	M. C. Cooke.
50.	„ *Flustra pilosa* ...	... ...	Mr. Golding.
51.	„ *Flustra truncata*	... ...	M. C. Cooke.
52.	„ *Gemellaria bursaria*	... ...	G. Paton.
53.	„ *Gemellaria loricata*	... ...	Mr. Golding.
54.	„ *Gemellaria loricata*	... ...	M. C. Cooke.
55.	„ *Halodactylus* (in fluid)	... ...	C. Collins.
56.	„ *Hippothoa catenularia*...	... ...	M. C. Cooke.
57.	„ *Hippothoa divaricata*	... ...	„
58.	„ *Lafœa dumosa*...	... ...	„
59.	„ *Lepralia coccinca*	... ...	„
60.	„ *Lepralia granifera*, var.	... ...	„
61.	„ *Lepralia hyalina*, var. β	... ...	„
62.	„ *Membranipora membranacea*	... ...	„
63.	„ *Membranipora pilosa*	... ...	„
64.	„ *Membranipora pilosa*, var.	... ...	„
65.	„ *Menipea ternata*	... ...	„
66.	„ *Notamia bursaria*	... ...	G. Paton.
67.	„ *Salicornaria sinuosa*	... ...	M. C. Cooke.
68.	„ *Serialaria lendigera*	... ...	G. Paton.
69.	„ *Tubulipora hispida*	... ...	M. C. Cooke.

3. Coleoptera.

70.	Alimentary canal of *Melolontha* **B**	... ...	T. C. White.
71.	Antenna of Cockchafer **B**	... .	A. Topping.
72.	Brazilian Beetle	... ...	W. H. Golding.
73.	Green Weevil ...	... ...	T. C. White.
74.	Elytra of Chinese Diamond Beetle	... ...	W. H. Golding.
75.	„ *Dytiscus* **B** ...	... ...	W. Hainworth.
76.	„ Green Weevil...	... ...	S. J. McIntire.
77.	„ *Otiorhynchus picipes* ...	... ...	M. C. Cooke.

B.		Donor.
78.	Foot of *Dytiscus*	J. A. Archer.
79.	,, *Dytiscus*	J. F. Pickard.
80, 81.	Larval hairs of *Tiresias serra* **B**	S. J. McIntire.
82.	Leg of Rose Beetle	L. Bennett.
83.	Spiracle of *Carabus* **B**...	Mr. Oxley.
84.	,, *Dytiscus* **B**...	,,
85.	,, *Dytiscus* **B**...	A. Topping.
86, 87.	,, *Dytiscus*	J. A. Archer.
88.	,, Stag Beetle **B**	Mr. Oxley.
89.	,, *Syrphus* **B**...	,,
90.	Trachæa of larva of *Dytiscus* **B**	A. Topping.

4. Hymenoptera.

91.	Antennæ of *Encyrtus punctipes* **B**	M. C. Cooke.
92.	Foot of *Wasp* **B**	G. Paton.
93.	Proboscis of Bee, *Apis mellifera* **B**	G. E. Quick.
94.	Sting, poison bag, &c., of Wasp **B**	T. C. White.
95.	Tongue of Bee **B**	G. E. Quick.
96.	,, Wasp, *Vespa vulgaris* **B**	T. C. White.
97.	Wing-hooks of *Apis mellifica* **B**...	G. E. Quick.
98.	,, *Andrena albicrus* **B**	M. C. Cooke.
99.	,, *Bombus muscorum* **B**	,,
100.	,, *Chrysis ignita* **B**...	,,
101.	,, *Odynerus parietum* **B**	,,
102.	,, *Uroceros gigas* **B**...	,,
103.	,, *Vespa germanica* **B**	,,
104.	,, *Vespa vulgaris* **B**	,,

5. Lepidoptera.

105.	Antennæ of *Amphidasis prodromaria* **B**... ...	M. C. Cooke.
106.	,, *Himera pennaria*	,,
107.	,, *Orgyia antiqua* **B**	,,
108.	Eggs of *Abraxas grossulariata*, Magpie	,,
109.	,, *Aplecta nebulosa*, Grey Arches	,,
110.	,, *Biston hirtaria*, Brindled Beauty ...	,,
111.	,, *Boarmia rhomboidaria*, Willow Beauty ...	,,
112.	,, *Cerura vinula*, Puss	,,
113.	,, *Lycœna phlœas*	,,
114.	,, *Mamestra brassicœ*, Cabbage	,,
115.	,, *Orgyia antiqua*, Vapourer	,,
116,117	,, Do.	W. Hainworth.
118.	,, *Pieris brassicœ*, Large White	M. C. Cooke.
119.	,, *Polyommatus Alexis*	,,
120.	,, *Tanagra chœrophyllata*	,,
121.	,, *Thecla betulœ*, Brown Hairstreak ...	,,
122.	,, *Vanessa atalanta*	,,
123.	,, *Vanessa urticœ*, Tortoiseshell	,,
124.	Embryo wings of Tortoiseshell Butterfly	T. C. White.
125.	Hair of larva of *Orgyia antiqua*	M. C. Cooke.
126.	Head of Silkworm moth...	T. Curties.

B.		Donor.
127.	Plumules of *Hipparchia Janira*	M. C. Cooke.
128.	„ *Pieris Rapæ*	„
129.	„ *Polyommatus acis*	„
130.	„ *Polyommatus Adonis*	„
131.	„ *Polyommatus aegon*	„
132.	„ *Polyommatus Alexis*	„
133.	„ *Polyommatus argiolus*	„
134.	„ *Polyommatus arion*	„
135.	„ *Polyommatus Bœtica*	„
136.	„ *Polyommatus Corydon*	„
137.	„ *Polyommatus Dorylus*	„
138.	Scales of *Antheræa paphia* ♂ (India)	„
139.	„ *Bia actorion*	„
140.	„ *Biston hirtaria*	„
141.	„ *Erycina pyretus* (Brazil)	„
142.	„ *Hemerophila abruptaria*	„
143.	„ *Hipparchia Jania*	R. T. Lewis.
144.	„ *Ismene* (Madagascar)	M. C. Cooke.
145.	„ *Morpho Achilles*	„
146.	„ *Morpho Helena*	R. T. Lewis.
147.	„ *Pieris rapæ*	S. J. McIntire.
148.	„ *Polyommatus Alexis*	M. C. Cooke.
149.	„ *Polyommatus Argiolus*	Mr. Oxley.
150.	„ Tiger moth	S. J. McIntire.
151.	„ *Vanessa Urticæ*	M. C. Cooke.
152.	Silk of *Antheræa Paphia* (India) Tusser	„
153.	„ *Antheræa Assama* (India) Moonga... ...	„
154.	„ *Attacus ricini* (India) Eria	„
155.	„ *Bombyx mori*	„
156.	Skin of Caterpillar **B**	A. Topping.
157, 158.	Wing of *Agraulis Juno* (Brazil)	M. C. Cooke.
159.	„ *Bia actorion*	„
160.	„ *Erycina pyretus* (Brazil)	„
161.	„ *Helecopis cupedo*	„
162.	„ *Hetaera aurora* (Brazil)	„
163.	„ *Morpho Achilles*	„
164.	„ *Morpho Helena* (?)	S. J. McIntire.
165.	„ *Papilio Paris*	W. Hainworth.
166.	„ *Pontia Brassicæ*	E. Marks.
167.	„ *Pontia Rapæ*	„
168, 169.	„ Red Admiral...	S. J. McIntire.
170.	„ *Trochilium myopæforme*	M. C. Cooke.
171.	„ Yellow Underwing	E. Marks.

6. Diptera.

172, 173.	Blow Fly labium (Lowne, p. 47) **B**	T. C. White.
174.	„ Operculum (Lowne, t. 2. f. 7) **B** ...	„
175.	„ (Lowne, pp. 47-8) **B** ...	„
176.	„ portion of section of eye (Lowne, p. 7) **B**	„
177.	„ Proboscis **B**	„

B.		Donor.
178.	Blow Fly Rectal papillæ, and egg in oviduct **B** ...	T. C. White.
179.	,, (Anatomical preparation) **B**	,,
180 to 184.	,, Rectal papillæ (Lowne, p. 58) **B** ...	,,
185 to 187.	,, Salivary duct and valve (Lowne, p. 52) **B**	,,
188.	,, Spiracles of pupa **B**...	,,
189.	,, Spiracles of pupa of Fly. **B**	,,
190.	,, Thoracic spiracles of Fly. **B**	,,
191.	,, (Anatomical preparation) **B**	,,
192.	,, Wing **B**	S. J. McIntire.
193.	Crane Fly, *Tipula* **B**	R. E. Edmonds.
194.	Eggs of House Fly (*Anthomyia*)	M. C. Cooke.
195.	Eye of Drone Fly **B**	G. E. Quick.
196.	Foot of do. **B**	S. J. McIntire.
197, 198.	Foot of Embryo Fly **B**	T. Curties.
199.	Halteres of Fly **B**	T. C. White.
200.	Head of *Tipula oleracea*	G. E. Quick.
201.	,, *Hippobosca equina* **B**	T. Curties.
202.	Larva of Bot Fly in the egg **B**	A. Topping.
203.	Mosquito (?), *Culex pipiens* ♀	R. E. Edmonds.
204.	,, ,, ♂	,,
205.	,, ,, lancets	,,
206.	,, ,, wings **B**	,,
207.	,, ,, lancets **B**	,,
208.	Mosquito (American), cluster of eggs	Dr. Perley.
209.	,, ,, eggs	,,
210.	,, ,, larva two days old	,,
211.	,, ,, mature larva	,,
212.	,, ,, ♀	,,
213.	,, ,, ♀ **B**	,,
214.	Tongue of Drone Fly **B**	S. J. McIntire.
215.	Wing of Rain Fly, *Anthomyia pluvialis* **B** ...	M. C. Cooke.
216.	Orange Fly, *Ceratites citriperda* **B**	,,

7. Aphaniptera.

217.	Chigöe, *Pulex penetrans* ♂ **B**	Dr. Gray.
218.	,, ,, ,, ♀ **B**	,,
219.	,, ,, ,, ♀ with ova **B**	,,
220.	Flea of Squirrel, *Pulex sciurorum* ♂ **B**	M. C. Cooke.
221.	,, ,, ,, ,, ♀ **B**	,,
222.	,, ,, ,, ,, larva **B**	,,
223.	Pygidium of Flea ♀ ... **B**	Mr. Conder.

8. Neuroptera.

224, 225.	Dragon Fly, Spiracles...	J. A. Archer.
226.	,, Trachea	,,
227.	,, Larva	,,
228.	,, Respiratory organs	,,

9. Orthoptera.

229.	Gizzard of *Blatta orientalis* **B**	T. C. White.
230.	,, ,, ...	G. E. Quick.

B.		Donor.
231.	Gizzard of Cricket	Mr. Conder.
232.	" (Trans. sect.) **B**	G. E. Quick.
233.	Grasshopper Tail (long. sect.) **B**...	Mr. Bennett.

10. Hemiptera.

234.	Aphis	G. Paton.
235.	*Chelymorpha phyllophora* **B**	T. C. White.

11. Thysaneura.

236.	Scales of *Degeeria domestica*	Mr. Oxley.
237.	" *Degeeria*	S. J. McIntire.
238.	" *Lepisma saccharina*	G. E. Quick.
239.	" *Lepidocyrtus*	S. J. McIntire.
240.	" *Macrotoma plumbea*	"
241.	" Podura	W. W. Reeves.
242.	" Speckled Podura	"
243.	" *Templetonia nitida*	S. J. McIntire.

12. Anopleura.

244.	Eggs of Parasite of Australian Crane	M. C. Cooke.
245.	" Bohemian Pheasant	"
246.	" Common Rhea	"
247.	" Ground Hornbill, No. 1 ...	"
248.	" Ground Hornbill, No. 2 ...	"
249.	Leg of Fly and parasites **B**	T. Curteis.
250.	Parasite of Duck **B**	G. E. Quick.
251.	" Gold Pheasant, *Nirmus sinensis* **B** ...	M. C. Cooke.
252, 253.	" Goose **B**	G. E. Quick.
254.	" Knott, *Nirmus holophæus.* ♂ **B** ...	S. Bramhall.
255.	" Knott, *Nirmus holophæus.* ♀ **B** ...	"
256.	" Partridge, *Menopon perdicis.* ♀ **B** ...	"
257.	" Partridge, *Goniodes colchici.* ♀ **B** ...	"
258, 259.	" Pig **B**	G. E. Quick.
260.	" Sheldrake, *Lipeurus polytrapezius.* ♀ **B**	S. Bramhall.
261.	" Starling **B**...	G. E. Quick.
262.	*Pediculus pubes* **B**	T. C. White.
263.	Phthirius (Denny's Anopl. p. 9) **B**	"
264.	Pigeon louse, *Lipeurus baculus.* ♂ **B**	M. C. Cooke.
265.	" *Lipeurus baculus.* ♀ **B**	"
266.	" *Goniocotes compar* **B**	"

13. Arachnida.

267.	Araignée patte et ongees **B**	G. Paton.
268.	Claw of *Epeira* **B**	S. J. McIntire.
269.	" Spider **B**	"
270.	Eyes of Spider	G. Paton.
271.	Foot of Spider **B**	G. E. Quick.
272.	Hair of Red Spider (India) **B**	G. Potter.
273.	Legs and claws of Spider **B**	A. Topping.
274.	Palpi of Spider **B**	M. C. Cooke.

B.		Donor.
275.	Poison gland of *Tegenaria* **B**	S. J. McIntire.
276.	Skin of *Epeira diadema* **B**	"
277.	Spinnerets of Spider **B**	A. Topping.
278.	Spinnerets of Spider **B**	T. C. White.

279.	*Chelifer* sp. —— **B**	T. Curties.
280.	*Chelifer Latreillei* **B**	S. J. McIntire.
281.	*Obisium* sp. —— **B**	"
282.	*Obisium orthodactylum* **B**	M. C. Cooke.
283.	Eggs of Stone Mite, *Trombidium lapidum* ...	"
284, 285.	Harvest Bug, *Trombidium autumnale* **B** ...	Miss Webb.
286.	" " " **B** ...	T. Curties.
287.	Mite, *Trombidium* **B**	S. J. McIntire.
288.	Parasite of Boa Constrictor **B**	J. Bockett.
289.	" Dytiscus **B**	J. A. Archer.
290.	" Itch, *Sarcoptes scabiei* **B**	C. Collins.
291.	" Tortoise **B**	T. Curties.
292.	Water Spider **B**	"

14. Crustacea.

293.	*Argulus foliaceus* **B**	T. C. White.
294.	*Bairdia subdeltoidea* (The Crag, Suffolk) ...	G. Paton.
295.	Crab, hairs from abdominal appendages **B** ...	"
296.	Crab shell, tubules (?)	M. Martinelli.
297.	*Cythere striatopunctata* (Barton)	G. Paton.
298.	*Cythere striatopunctata* (Highcliff)	"
299.	*Cythere torosa* (Grays, Essex)	
300.	*Cythereis quadrilatera* (Kent)	
301.	*Cytherella ovata* (The Gault, Kent)	
302.	Legs of Prawn **B**	T. C. White.
303.	Lobster shell, section perpendicular **B**	T. Curties.
304.	Trilobite, *Phacops Muchenii*	W. W. Reeves.
305.	Water Flea, *Daphnea mucronata* **B**	T. Curties.

15. Myriapoda, Annulosa, &c.

306.	Pencil tail *Polyxenus lagurus*, hairs **B**	S. J. McIntire.
307.	Trachæa of Centipede **B**	A. Topping.
308.	Hairs of Sea Mouse, *Aphrodita*	"
309.	" *Aphrodita hystrix*	Mr. Oxley.
310, 311.	*Mermis nigrescens*	R. T. Lewis.
312.	" Ova (acetic acid)	"

16. Echinodermata.

313.	Calcareous plates from Star fish	G. Paton.
314.	Crinoidal joints, (chalk marl, Kent)	"
315.	Echinus spine **B**	F. Marshall.
316.	" *Amphidotus cordatus*	M. C. Cooke.
317.	" *Acrocladia* **B**	F. Marshall.
318.	" *Cidaris* (Fossil) **B**	"
319.	" *Echinus* **B**	W. Moginie.
320.	" *Echinus miliaris*	M. C. Cooke.

B.		Donor.
321.	Echinus spine *Heliocidaris* **B**	F. Marshall.
322.	,, *Leiocidaris imperialis* **B**	,,
323.	,, *Parasatenia gratiosa* **B**	,,
324.	Spatangus spines	G. Paton.
325.	Star fish, *Ophiocoma*, spines	W. W. Reeves.
326.	,, *Ophiocoma neglecta*	S. J. McIntire.

17. Actinozoa.

327.	Part of Alcyonite with spicules in situ (Fossil) ...	J. G. Waller.
328.	Skin of *Synapta inherens* **B**	J. Slade.
329.	,, *Synapta digitata* **B**	,,
330.	*Acanthogorgia Johnsonii*...	A. C. Cole.
331.	Spicules of Alcyonite (Fossil) **B**	J. G. Waller.
332.	,, *Alcyonium digitatum*	Mr. Oxley.
333.	,, *Alcyonium digitatum* **B**	W. W. Reeves.
334.	,, ,, ,, **B**	M. C. Cooke.
335.	,, *Eunicea*	A. C. Cole.
336.	,, *Gorgonia*	G. Paton.
337.	,, ,, **B**	W. W. Reeves.
338.	,, ,, **B**	J. Russell.
339.	,, ,, ...	A. C. Cole.
340.	,, *Gorgonia verrucosa* **B**...	W. W. Reeves.
341.	,, ,, ,, **B**...	M. C. Cooke.
342.	,, *Gorgonia* (Mauritius) **B**	M. C. Cooke.
343.	,, *Holothuria* **B**	W. W. Reeves.
344.	,, *Homophyton githago*	A. C. Cole.
345.	,, *Leptogorgia*	,,
346.	,, *Leptogorgia* (N. Carolina) **B**	Exchange.
347.	,, *Lophogorgia palma*	A. C. Cole.
348.	,, *Melithœa*	,,
349.	,, *Melithœa coccinea*	,,
350.	,, *Melithœa coccinea* **B**	M. C. Cooke.
351.	,, *Melithœa ochracea*	A. C. Cole.
352.	,, *Muricea*	,,
353.	,, *Phyllogorgia dilatata*...	,,
354.	,, *Plexaura*	,,
355.	,, *Plexaura salicornoides* (No. 1)... ...	,,
356.	,, *Plexaura salicornoides* (No. 2) **B** ...	,,
357.	,, *Primnoa verticulosa*	,,
358.	,, *Pterogorgia petechizans*	,,
359.	,, *Rhiphidogorgia flabellum*	,,
360.	,, *Synapta inhœrens* **B**	Mr. Kilsby.
361.	,, *Xiphigorgia anceps*	A. C. Cole.
362.	Spicules (unnamed)	,,
363.	Spicules (unnamed) **B**	,,

18. Hydrozoa.

364, 365.	*Aglaophenia pluma*	M. C. Cooke.
366.	*Antennularia antennina*	W. H. Golding.
367.	*Antennularia antennina*	M. C. Cooke.
368, 369.	*Antennularia ramosa*	,,

B.		Donor.
370, 371, 372.	Coralline from Queensland	T. Curties.
373, 374.	*Halecium halecinum*	M. C. Cooke.
375.	*Halecium halecinum*	W. H. Golding.
376.	*Plumularia catherina*	M. C. Cooke.
377.	*Plumularia cristata* **B**	G. Paton.
378.	*Plumularia falcata*	M. C. Cooke.
379.	*Plumularia falcata*	W. H. Golding.
380.	*Plumularia myriophyllum*	M. C. Cooke.
381.	*Plumularia pennata*	W. H. Golding.
382.	*Sertularia* **B**	
383.	*Sertularia*	G. Paton.
384.	*Sertularia argentea*	W. H. Golding.
385.	*Sertularia cupressina*	,,
386.	*Sertularia cupressina*	M. C. Cooke.
387.	*Sertularia filicula*	,,
388.	*Sertularia margareta*	,,
389.	*Sertularia operculata*	,,
390.	*Sertularia operculata*	W. H. Golding.
391.	*Sertularia plumula* **B**	G. Paton.
392.	*Sertularia polyzonias*	M. C. Cooke.
393.	*Sertularia polyzonias*, var.	,,
394.	*Sertularia polyzonias*, var. β	,,
395.	*Thuiaria thuia*	,,
396.	*Tubularia larynx*	,,

18. Protozoa—Spongiadæ.

397.	*Euplectella aspergillum*, Siliceous hairs	H. F. Hailes.
398.	Gemmules of *Spongilla Meyeni* (India)	M. C. Cooke.
399.	Gemmules and Spicules of *Pachymatisma*	F. Kitton.
400.	Section of *Spongilla cinerea* (India)	M. C. Cooke.
401.	Spicules of *Chalina oculata* **B**	,,
402.	,, *Clione celata* **B**	,,
403.	Sponge, *Dictyocylindrus ramosus* **B**	,,
404.	Spicules of *Dictyocylindrus ramosus* **B**	,,
405.	Sponge, *Dysidea fragilis*	J. G. Waller.
406, 407.	,, *Grantia compressa*	M. C. Cooke.
408.	,, *Halichondria*	J. G. Waller.
409.	,, *Halichondria palmata*	W. H. Golding.
410.	Spicules of *Halichondria panicea* **B**	M. C. Cooke.
411.	,, *Hyalonema mirabile*, cruciform **B**	T. Curties.
412.	,, *Hyalonema mirabile* **B**	M. C. Cooke.
413.	Sponge, *Hymeniacidon*	J. G. Waller.
414.	Spicules of *Hymeniacidon Bucklandi* **B**	M. C. Cooke.
415.	,, *Hymeniacidon celata* **B**	J. G. Waller.
416.	,, *Isodictya* sp. (W. Indies) **B**	M. C. Cooke.
417.	,, *Raphiophora patera* **B**	,,
418.	Sponge, *Spongilla alba* (India)	,,
419.	Spicules of *Spongilla alba* (India) **B**	,,
420.	,, *Spongilla fluviatilis* (variety ?) **B**	,,
421.	,, *Spongilla Meyeni* (India) **B**	,,
422.	Sponge, *Spongilla plumosa* (India)	,,

B.		Donor.
423.	Spicules of *Spongilla plumosa* (India)	M. C. Cooke.
424.	„ *Tethea Logani* (Fossil)	„
425.	*Spongilla lacustris*	J. G. Waller.
426.	„ „ spicules **B**	„
427.	„ „ ovaria **B**	„
428.	„ „ dermal membrane **B**	„
429.	„ „ longitudinal section	„
430.	Spicules from Trinidad deposit **B**...	T. Curties.
431.	Spicules of Sponge **B**	W. Hainworth.
432.	Sponge spicules (Algoa Bay) **B**	F. Kitton.
433.	Sponge spicules **B**	„

20. Protozoa—Foraminifera.

434.	Atlantic ooze **B**	C. Collins.
	Atlantic soundings—	
435.	„ N. lat. 42 22′ W. lon. 57° 16′ 13.600 fath....	R. T. Lewis.
436.	„ „ 44 23′ „ 54° 29′ 9.100 f. ...	„
437.	„ „ 47 „ 20° 21′ 12.000 f. ...	„
438.	„ „ 43 44′ „ 37° 4′ 12.300 f. ...	„
439.	„ „ 43° 6′ „ 59° 32′ 14.400 f. ...	„
440.	„ „ 45° 42′ „ 47° 37′ 3.600 f. ...	„
441.	„ „ 43° 29′ „ 53° 1′ 9.000 f. ...	„
442.	„ *Bulimina obtusa*	G. Paton.
443.	„ *Bulimina variabilis*	„
444.	„ *Dentalina communis*	„
445.	Chalk **B**	A. Topping.
446.	„ *Globigerina bulloides*	G. E. Quick.
447.	„ *Lagena sulcata* (Connemara) ...	T. Russell.
448.	„ *Miliolina seminulum*	M. C. Cooke.
449.	„ *Nummularia variolaria*... ...	
450.	*Nummulina laevigata* (Bracklesham)	G. Paton.
451.	*Nummulina planulata*...	„
452.	Nummulitic Limestone (Pyramids, Egypt) **B** ...	Mr. Simson.
453.	*Orbitoides* (Cuba)	M. C. Cooke.
454.	*Orbitolites complanatus*	Mr. Simson.
455.	*Orbitolites*	G. E. Quick.
456.	*Peneroplis*	M. C. Cooke.
457.	*Placopsilina irregularis*	
458.	Polythalamia (Mount of Olives) **B**	Mr. Simson.
459.	*Rotalia* from Chalk (Dover) **B**	G. Paton.
460.	*Rotalina Beccarii*	M. C. Cooke.
461.	*Rotalina and Globigerina* **B**	H. F. Hailes.
462.	*Rotalina, Globigerina, and Lagena* **B**	„
463.	*Spirolina*	M. C. Cooke.
464.	*Textularia trochus*	
465.	*Textularia trochus*	G. Paton.
466.	*Triloculina nitida*	M. C. Cooke.
467.	Mixed Foraminifera (China seas)	A. C. Cole.
468.	„ (Dog's Bay, Ireland)... ...	„
469.	„ (Red Sea, 105 faths.) ...	„

B		Donor.
470.	Mixed Foraminifera (Isle of Wight)	M. C. Cooke.
471.	,, (Cuba)	,,
472.	,, (Mediterranean)	,,
473.	,, (Turkey)	,,
474, 475.	,, (Burns Pool, Connemara) ...	,,
476, 477.	Soundings (Bay of Bengal)	F. Kitton.
478.	,, ...	H. F. Hailes.
479.	,, (East Coast, Bay of Bengal) ...	,,
480.	,, (Cape Wrath)	P. Gray.

21. PROTOZOA—POLYCYSTINA.

Nos. 481 to No. 602 Contain the Bury Collection.

481.	Mixed Polycystins;	Arabian Sea, 1,300 fathoms **B**	Bury Coll.
482.	,, ,,	Atlantic soundings **B** ...	,,
483 to 526.	,, ,,	Barbados **B**	,,
527 to 550.	,, ,,	Cambridge, Barbados **B** ...	,,
551 to 565.	,, ,,	Chimborazo **B**	,,
566.	,, ,,	Indian Ocean **B**	,,
567.	,, ,,	Indian Ocean, 2,200 fathoms **B**	,,
568.	,, ,,	Pike of Teneriffe **B**... ...	,,
569.	,, ,,	Spain **B**	,,
570 to 590.	,, ,,	Springfield, Barbados **B** ...	,,
591 to 601.	,, ,,	Trinidad, Naparima **B** ...	,,
602.	,, ,,	Vaughban **B**	,,
603.	Selected Polycystins	... ...	Dr. Dempsey.
604.	,, ,,	Springfield, Barbados ...	A. C. Cole.
605.	,, ,,	,, ,, ...	,,
606.	,, ,,	,, ,, **B** ...	M. C. Cooke.

VEGETABLE.

Sect. C.—PHANEROGAMIA.

1. STEMS.

C		
1.	*Adansonia digitata*, Baobab (section)	M. C. Cooke.
2.	*Antiaris toxicaria*, Upas	,,
3.	*Aristolochia ornithocephalus*	,,
4.	*Aristolochia*	,,
5.	*Berberis vulgaris*, Berberry	,,
6.	*Castanea vesca*, Chestnut	,,
7.	*Cedrus deodara*, Deodar	,,
8.	*Cinnamomum Zeylanicum*, Cinnamon	,,
9.	*Citrus aurantium*, Orange	,,
10.	*Clematis vitalba*, Clematis	,,
11.	Ebony (Transverse) **B**	G. E. Quick.
12.	*Fagus sylvatica*, Beech	M. C. Cooke.
13.	Fossil wood (Texas)	T. Curties.

C.		Donor.
14.	*Larix Europæus*, Larch	M. C. Cooke.
15.	*Laurus tinus*	„
16.	Maple (Transverse) **B**	G. E. Quick.
17.	*Morus nigra*, Mulberry	M. C. Cooke.
18.	*Passiflora sp.*, Passion flower	„
19.	Pine section **B**	A. Topping.
20.	*Populus nigra*, Poplar	T. Rogers.
21.	*Prunus cerasus*, Cherry	M. C. Cooke.
22.	*Rubus vitis idæus*, Raspberry	„
23.	*Saccharum officinarum*, Sugar Cane **B**	A. Topping.
24, 25.	*Salix alba*, Willow	M. C. Cooke.
26.	*Sambucus ebulus*, Elder	„
27.	*Smilax* sp., Sarsaparilla	„
28.	*Swietenia mahagoni*, Mahogany **B**	G. E. Quick.
29.	„ „	M. C. Cooke.
30.	*Ulmus campestris*, Elm	„
31.	*Vitis vinifera*, Vine	„
32.	Walnut (Fossil)	Mr. Simson.
33.	*Wellingtonia gigantea*, Mammoth	M. C. Cooke.
34.	Whangee Cane (Section) **B**	T. F. Pickard.

2. Fibres.

35.	Adam's needle, *Yucca gloriosa* **B**	M. C. Cooke.
36.	Ambaree, *Hibiscus cannabinus* (Dry)	Fibre Committee.
37.	„ „ **B**	„
38.	Bariala, *Sida rhomboidea* (Dry)	„
39.	Bedolee, *Pæderia fœtida* (Dry)	„
40.	Flax, Yellow English (Glycerine)...	„
41.	„ „ (Dry)	„
42.	„ „ (Chloride of Calcium) ...	„
43.	„ Blue English (Glycerine)	„
44.	„ „ (Dry)	„
45.	„ „ **B**	„
46.	„ Yellow English line (Dry)	„
47.	„ „ **B**	„
48.	„ „ (Glycerine)	„
49.	„ „ (Nitric Acid and Balsam)	„
50.	„ „ (Nitric Acid and Glycerine)	„
51.	„ Blue English line (Dry)	„
52.	„ „ (Glycerine)	„
53.	„ „ (Balsam)	„
54.	Hemp, Polish Rhine (Dry)	„
55.	„ „ (Soda, Balsam)	„
56.	„ „ (Soda, Glycerine)	„
57.	„ „ (Nitric Acid, Balsam) ...	„
58.	„ „ (Nitric Acid, Glycerine) ...	„
59.	„ Italian, Bologna (Chloride of Calcium) ...	„
60.	„ „ (Dry)	„
61.	„ „ (Glycerine)	„
62.	„ „ (Balsam)	„
63.	Jetee, *Marsdenia tenacissima* **B**	M. C. Cooke.

C.		Donor.
64.	Jute, cleaned and bleached (Dry)	Fibre Committee.
65.	,, ,, (Balsam)	,,
66.	,, ,, (Glycerine)	,,
67.	,, ,, (Nitric acid and Chloride of Calcium	,,
68.	Kangra Hemp (Dry)	,,
69.	Mudar, *Calotropis gigantea*, (Dry)	,,
70.	Mudar, *Calotropis gigantea* **B**	M. C. Cooke.
71.	Roselle, *Hibiscus sabdariffa* (Dry)	Fibre Committee.
72.	,, ,, (Balsam)	,,
73.	Sunn, *Crotalaria juncea* (Dry)	,,
74.	,, ,, (Balsam)	,,

3. Cell Structure, &c.

75.	Oak Buttons	Mr. Golding.
76, 77.	Paper bark, *Melaleuca viridiflora* **B**	M. C. Cooke.
78.	Pith of Elder, *Sambucus* **B**	E. Marks.
79.	Raphides of Aloe **B**	T. Curties.
80.	,, Rhubarb **B**	B. D. Jackson.
81.	Resin glands of *Mallotus* sp. **B**	M. C. Cooke.
82.	,, *Mallotus Philippinensis* **B** ...	,,
83.	Section of Aloe	W. J. Arnold.
84.	,, Comfrey leaf...	,,
85.	,, India rubber leaf	G. Paton.
86, 88.	,, Midrib of Tobacco	J. A. Archer.
89.	,, *Monstera deliciosa*	W. J. Arnold.
90.	,, *Oleander neriiformis*...	R. T. Lewis.
91.	,, Rush **B**	G. Oxley.
92, 93.	,, Tobacco leaf	J. A. Archer.
94.	Spiral threads of *Nymphœa edulis* **B**	M. C. Cooke.
95.	Spiral vessels (compound)	T. Curties.
96.	Spiral vessels of Rhubarb	T. Rogers.
97.	Vegetable Ivory (section) **B**	A. Topping.
98.	Ivory nut shell (vertical section) **B**	Mr. Simson.

4. Cuticles.

99.	Cuticle of fruit of Prickly Pear	W. M. Bywater.
100.	Cuticle of leaf *Agave Americana*	,,
101.	,, ,, *Aloe variegata*	N. Burgess.
102.	,, ,, *Hoya bella* (upper side) ...	W. J. Arnold.
103.	,, ,, ,, (under side) ...	,,
104.	,, ,, *Hoya carnosa*	W. M. Bywater.
105.	,, ,, *Hoya carnosa* (upper side) ...	W. J. Arnold.
106.	,, ,, ,, (under side) ...	,,
107.	,, ,, *Pandanus Veitchii*	,,
108, 109.	,, ,, *Rhododendron*	,,
110.	,, ,, *Sanseviera carnea*	,,
111.	,, ,, Tobacco	J. A. Archer.
112.	,, ,, *Yucca gloriosa* (upper side) ...	T. Curties.
113.	,, ,, ,, (under side) ...	,,
114.	,, Malacca cane	J. F. Pickard.
115.	,, Pitcher, *Nepenthes*	W. J. Arnold.
116.	Cuticle (Siliceous), *Gynerium argenteum*... ...	,,

5. Hairs, &c.

C.			Donor.
117.	Calyx of Abutilon venosum	... ...	W. M. Bywater.
118.	Cotton, American, *Gossypium barbadense*	...	M. C. Cooke.
119.	,, Dacca ,, ,,	...	,,
120.	,, Indian *Gossypium herbaceum*	... ...	,,
121.	Hairs of *Correa*, petal	... ...	T. C. White.
122.	,, *Deutzia*	... ...	R. T. Lewis.
123.	,, *Leucodendron argenteum*, "Silver leaf"	...	M. C. Cooke.
124.	,, *Rhododendron ferrugineum*	... ...	W. M. Bywater.
125.	,, Tobacco	... ...	J. A. Archer.
126.	Leaf of *Althæa rosea* with hairs	... ...	M. C. Cooke.
127.	,, *Alyssum calycinum* ,,	... ...	,,
128.	,, *Aralia papyrifera* ,,	... ...	,,
129.	,, *Correa cardinalis* ,,	... ...	,,
130.	,, *Cheiranthus cheiri* ,,	... ...	,,
131.	,, *Elæagnus pungens* ,,	... ...	,,
132.	,, *Lavatera arborea* ,,	... ...	,,
133.	,, *Rhamnus* ,,	... ...	,,
134.	,, *Shepherdia argentea* ,,	... ...	,,
135.	,, *Viburnum lantana* ,,	... ...	,,
136.	Petal of Balsam	... ...	G. Paton.
137.	,, Geranium	... ...	A. Topping.
138.	Pistil of *Salvia*	... ...	G. Paton.
139.	Scales of *Elæagnus* (Niagara Falls) **B**	... ...	M. C. Cooke.
140.	,, *Elæagnus angustifolia*	... ...	T. C. White.
141.	,, *Rhododendron Dalhousiana*	... ...	W. M. Bywater.
142.	Silk Cotton, *Calotropis gigantea*	... ...	M. C. Cooke.
143.	Spines of *Opuntia microdasya*	... ...	W. M. Bywater.
144.	,, ,, ,, **B**	... ...	,,
145.	Finest Indian Muslin **B**	... ...	M. C. Cooke.

6. Pollen.

146.	Pollen of *Althæa rosea*, Hollyhock	... ...	G. E. Quick.
147.	,, *Camellia*	... ...	J. W. Groves.
148.	,, *Cedrus Libani*, Cedar	... ...	
149.	,, *Crocus*	... ...	J. W. Groves.
150.	,, *Galanthus nivalis*, Snowdrop	... ...	M. C. Cooke.
151.	,, *Lilium*, White Lily	... ...	J. W. Groves.
152.	,, *Malva sylvestris*, Mallow	... ...	S. J. McIntire.
153.	,, *Œnothera biennis*	... ...	T. C. White.
154, 155.	,, *Pinus pinaster*	... ...	G. E. Quick.
156.	,, ,,	... ...	M. C. Cooke.
157.	,, *Primula vulgaris*, Primrose	... ...	,,
158.	,, ,, ,,	... ...	J. W. Groves.
159.	,, *Pyrus Japonica*	... ...	,,
160.	,, *Ranunculus ficaria*	... ...	M. C. Cooke.
161.	,, *Taraxacum dens leonis*	... ...	,,
162.	,, *Viola odorata*, Violet	... ...	,,
163.	Stamens of Bog Asphodel	... ...	W. M. Bywater.

7. Seeds.

C.		Donor.
164.	*Achillea millefolium*, Milfoil	M. C. Cooke.
165.	*Achyrachæna mollis*	,,
166.	*Adanophora denticulata*	
167.	*Adlumia cirrhosa*	,,
168.	*Agrostemma cirrhosa*	,,
169.	*Agrostemma coronaria*	,,
170.	*Alonzoa incisifolia*	,,
171.	*Alonzoa Warszewicsii*	,
172.	*Alyssum maritimum*	,,
173.	*Alyssum saxatile*	,,
174.	*Anagallis carnea*	,,
175.	*Anagallis Indica*	,,
176.	*Anchusa sempervirens*	,,
177.	*Antirrhinum* sp. Snapdragon	E. Marks.
178.	*Antirrhinum* sp. Snapdragon	R. T. Lewis.
179.	*Antirrhinum majus*	M. C. Cooke.
180.	,, ...	G. E. Quick.
181.	*Antirrhinum orontium*...	M. C. Cooke.
182.	*Arabis alpina*...	,,
183.	*Arenaria montana*	,,
184.	*Armeria plantaginis*	,,
185.	*Astilbe rivularis*	,,
186.	*Bartonia aurea*	E. Marks.
187.	*Blumenbachia insignis*	M. C. Cooke.
188.	*Bocconia cordata*	,,
189.	*Bœhmeria nivea*, China Nettle	,,
190.	*Browallia elata*	,,
191.	*Cajophora aurantiaca*, Chili Nettle	,,
192.	*Cajophora lateritia*	,,
193.	*Calandrinia discolor*	,,
194.	*Calandrinia grandiflora*	,,
195.	*Calandrinia speciosa*	,,
196.	,, *umbellata*	,,
197.	*Calceolaria chelidonioides*	,,
198.	*Calluna vulgaris*, Ling	,,
199.	*Camelina sativa*, Gold of Pleasure	,,
200.	*Campanula carpathica*	,,
201.	*Campanula media*	,,
202.	*Campanula pentagona*	,,
203.	*Campanula pumila*	,,
204.	*Campanula pyramidalis*	,,
205.	*Campanula rapunculus*, Rampion	,,
206.	*Campanula speculum*, Venus Looking-glass ...	,,
207.	*Celosia cristata*	,,
208.	*Centranthus nanus*	,,
209.	*Centranthus ruber*, Red Valerian	,,
210.	*Cerastium Biebersteinii*	,,
211.	*Cerastium tomentosum*	,,
212.	*Chlora perfoliata*	,,
213.	*Chænostoma polyantha*	,,

C.		Donor.
214.	*Cistus helianthemum*	M. C. Cooke.
215.	*Clarkia elegans*	,,
216.	*Clarkia pulchella*	,,
217.	*Clintonia elegans*	,,
218.	*Clintonia pulchella*	,,
219.	*Collinsia bicolor*	,,
220.	*Collinsia grandiflora*	,,
221.	*Collomia grandiflora*	,,
222.	*Coreopsis* sp.	E. Marks.
223.	*Coreopsis atrosanguinea*	R. T. Lewis.
224.	*Cosmanthus fimbriatus*...	M. C. Cooke.
225.	*Crucianella stylosa*	,,
226.	*Cuphea purpurea*	,,
227.	*Daucus carota*, Carrot	R. T. Lewis.
228.	*Dianthus hyssopifolius*	M. C. Cooke.
229.	*Dianthus sinensis*	,,
230.	*Digitalis grandiflora*	,,
231.	*Digitalis lanata*	,,
232.	*Digitalis lutea*, Yellow Foxglove	,,
233.	*Digitalis purpurea*, Purple Foxglove	,,
234.	*Eschscholtzia tenuifolia*	,,
235.	*Eucharidium concinnum*	,,
236.	*Eucharidium grandiflorum*	,,
237.	*Eupatorium cannabinum*, Hemp Agrimony ...	,,
238.	*Eutoca multiflora*	,,
239.	*Eutoca viscida*...	,,
240.	*Exacum tetragonum*	,,
241.	*Fumaria sempervirens*	,,
242.	*Gentiana acaulis*	,,
243.	*Gentiana crinita*	,,
244.	*Gentiana lutea*, Yellow Gentian...	,,
245.	*Gilia bicolor*	,,
246.	*Gilia nivalis*	,,
247.	*Glaucium corniculatum*, Horn Poppy	E. Marks.
248.	*Glaucium Fischeri*	M. C. Cooke.
249.	*Glaucium luteum*, Yellow Horn Poppy	,,
250.	*Globularia trichosantha*	,,
251.	*Godetia alba*	,,
252.	*Godetia tenella*	,,
253.	*Gypsophila elegans*	,,
254.	*Gypsophila muralis*	,,
255.	*Heliophila araboides*	,,
256.	*Heliotropium Peruvianum*, Heliotrope	,,
257.	*Hesperis matronalis*, Rocket	,,
258.	*Heuchera pubescens*	,,
259.	*Hunnemannia fumariæfolia*	,,
260.	*Hyoscyamus pictus*	,,
261.	*Ipomopsis elegans*	,,
262.	*Isoplexis Canariensis*	,,
263.	*Isotoma axillaris*	,,
264.	*Isotoma longiflora*	,,

C.		Donor.
265.	*Isotoma petræa*	M. C. Cooke.
266.	*Jamesia Americana*	,,
267.	*Jussiæa* sp. (India)	,,
268.	*Leptosiphon androsaceus*	,,
269.	*Leptosiphon aureus*	,,
270.	*Linaria cymbalaria*	,,
271.	*Linaria saxatilis*	,,
272, 273.	*Linaria spartea*	,,
274.	*Linaria speciosa*	,,
275.	*Linaria triornithophora*	,,
276.	*Linaria triphylla*	,,
277.	*Loasa Herbertii*	E. Marks.
278.	,, *tricolor*	Mr. Jackson.
279.	*Lobelia gracilis*	G. E. Quick.
280, 281.	*Lophospermum Hendersonii*	,,
282.	*Lophospermum scandens*	M. C. Cooke.
283.	*Lychnis chalcedonica*	,,
284.	*Lychnis* sp.	E. Marks.
285.	*Maurandya Barclayana*	M. C. Cooke.
286.	*Meconopsis Cambrica*, Welsh Horn Poppy ...	,,
287.	*Mesembryanthemum glabrum*	,,
288.	*Mesembryanthemum* ,, Ice Plant	G. E. Quick.
289.	*Michauxia campanulata*	M. C. Cooke.
290.	*Microsperma bartonioides*	,,
291.	*Mimulus cardinalis*	,,
292.	*Mimulus luteus*, Yellow Monkey Flower	,,
293.	*Mimulus moschatus*, Musk Plant	,,
294.	*Monotropa uniflora*	,,
295.	*Musschia Wollastonii*	,,
296.	*Myosotis alpestris*	,,
297.	*Myosotis palustris*	,,
298.	*Myosotis sylvatica*	,,
299.	*Nemesia floribunda*	,,
300.	*Nemesia versicolor*	,,
301.	*Nemophila insignis*	,,
302.	*Nicotiana* sp., Tobacco	E. Marks.
303.	,, Oronoco Tobacco	G. E. Quick.
304.	*Nicotiana rustica*, Hungarian Tobacco	M. C. Cooke.
305.	*Nycterinia capensis*	,,
306.	*Nycterinia selaginoides*	,,
307.	*Ocymum basilicum*, Basil	,,
308.	*Œnothera biennis*, Evening Primrose	,,
309.	,, *veitchiana*	,,
310.	*Ophrys apifera*, Bee Orchis	,,
311.	*Origanum marjorana*, Marjoram	,,
312.	*Oxalis corniculata*	,,
313.	*Oxalis rosea*	,,
314.	*Oxyura chrysanthemoides*	,,
315.	*Papaver bracteatum*	,,
316.	*Papaver nigrum*	,,
317.	,, *rhœas*...	G. E. Quick.

C.		Donor.
318.	*Papaver somniferum*, White Opium Poppy ...	M. C. Cooke.
319.	*Papaver somniferum*, Grey Opium Poppy ...	"
320.	" "	G. E. Quick.
321.	*Papaver* sp., Carnation Poppy	R. T. Lewis.
322.	*Paulownia imperialis*	M. C. Cooke.
323.	*Petunia* sp.	E. Marks.
324.	*Petunia violacea*	M. C. Cooke.
325.	*Perilla Nankinensis*	"
326.	*Phacelia tanacetifolia*	"
327.	*Phlox Drummondi*	"
328.	*Phyteuma campanuloides*	"
329.	*Plantago major*, Plantain	"
330.	*Plantago psyllium*	"
331.	*Platystemon Californicum*	"
332.	*Pogostemon plectranthoides*	"
333.	*Portulaca* sp.	W. M. Bywater.
334.	*Potentilla insignis*	M. C. Cooke.
335.	*Primula denticulata*	"
336.	*Primula veris*, Cowslip...	"
337.	*Pterospora* sp.	"
338.	*Reseda odorata*, Mignonette	"
339.	*Rhododendron arboreum*	"
340.	*Rhododendron campanulatum*	"
341.	*Rœmeria hybrida*	"
342.	*Salpiglossis luteus*	"
343.	*Saxifraga ciliata*	"
344.	*Saxifraga palmata*	"
345.	*Schizanthus Grahami*	"
346.	*Scrophularia nodosa*, Fig wort	"
347.	*Scutellaria alpina*	"
348.	*Scypanthus elegans*	"
349.	*Sedum aizoon*	"
350.	*Sedum cœruleum*	"
351.	*Sedum telephium*, Orpine	"
352.	*Silene alpestris*	"
353.	*Silene armeria*	"
354.	*Silene inflata*, Bladder Campion	G. E. Quick.
355.	*Silene pendula*	E. Marks.
356.	*Silene pendula*...	M. C. Cooke.
357.	*Silene picta*	"
358.	*Silene quadrifida*	"
359.	*Silene Schafta*...	"
360.	*Spergula arvensis*	"
361.	*Spergula pilifera*	"
362.	*Sphœnogyne speciosa*	E. Marks.
363.	*Spiræa filipendula*, Dropwort	M. C. Cooke.
364.	*Spiræa Lindleyana*	"
365.	*Sturmia Loeselii*	"
366.	*Tellinia grandiflora*	"
367.	*Thymus vulgaris*, Thyme	"
368.	*Thysanocarpus* sp.	"

C.		Donor.
369.	*Ulmus montana*, Wych Elm	M. C. Cooke.
370.	*Valeriana dioica*, Wild Valerian	,,
371.	*Verbascum nigrum*	,,
372.	*Verbascum thapsus*, Mullein	E. Marks.
373.	,, ,, ...	G. E. Quick.
374.	*Verbena Aubletii*	M. C. Cooke.
375.	*Verbena pulchella*	,,
376.	*Verbena pulcherrima*	,,
377.	*Verbena venosa*	,,
378.	*Vinca rosea*	,,
379.	*Viscaria oculata*	,,
380.	*Whitlavia grandiflora*	,,
381.	Winged seed	C. Collins.

8. STARCHES.

382.	*Æsculus hippocastanum.* **B**	M. C. Cooke.
383.	*Artocarpus incisa*, Breadfruit. **B**	,,
384.	*Artocarpus incisa*, Breadfruit	W. Hislop.
385.	*Arum colocasia* **B**	M. C. Cooke.
386.	*Arum colocasia*, Arum	W. Hislop.
387.	*Arum maculatum*, Wake Robin...	,,
388.	*Arum maculatum* **B**	G. E. Quick.
389.	*Batatas edulis*, Sweet Potato **B**...	M. C. Cooke.
390.	Bean **B**	G. E. Quick.
391.	*Canna indica*, Indian Shot **B**	M. C. Cooke.
392.	*Canna Indica*, Indian Shot	W. Hislop.
393.	*Canna* sp. Tous les mois	,,
394.	*Canna* sp. Tous les mois **B**	G. E. Quick.
395.	*Canna* sp. Tous les mois (Iodized)	S. J. McIntire.
396.	*Canna* sp. Tous les mois **B**	T. C. White.
397.	Colomba **B**	G. E. Quick.
398.	*Curcuma angustifolia* **B**	M. C. Cooke.
399.	*Curcuma angustifolia*	W. Hislop.
400.	*Curcuma* sp. Wild Ginger	,,
401.	*Cycas revoluta* **B**	M. C. Cooke.
402.	*Dioscorea alata*, Yam **B**	,,
403.	*Dioscorea alata*, Yam	W. Hislop.
404.	*Dioscorea* sp. Yam	,,
405.	Hyacinth **B**	G. E. Quick.
406.	*Ipomœa Horsfallii* **B**	M. C. Cooke.
407.	*Jatropha manihot*, Mandioc **B**	,,
408.	*Jatropha manihot*, Cassava	W. Hislop.
409.	*Jatropha manihot*, Tapioca	,,
410.	*Lilium* sp. Lily **B**	G. E. Quick.
411.	*Mangifera Indica*, Mango	W. Hislop.
412.	*Mangifera Indica*, Mango **B**	M. C. Cooke.
413.	*Maranta arundinacea* **B**	,,
414.	*Maranta arundinacea*	W. Hislop.
415.	*Musa paradisiaca*, Plantain	,,
416.	Nankin Starch	,,
417.	*Oryza sativa*, Rice	,,

C.		Donor.
418.	*Physostigma venenosum*, Calabar Bean	Mr. Conder.
419.	*Physostigma venenosum*	G. E. Quick.
420.	*Pisum sativum*, Pea	,,
421.	Rombiya Sago **B**	M. C. Cooke.
422.	Sago Meal	W. Hislop.
423.	Sago Starch (*Raphia?*) **B**	M. C. Cooke.
424.	*Solanum tuberosum*, Potato in situ	G. Paton.
425.	*Solanum tuberosum*, Potato **B**	M. C. Cooke.
426.	*Solanum tuberosum*, Potato	W. Hislop.
427.	,, ,, ...	G. E. Quick.
428.	Starch from Nut	G. Paton.
429.	*Tacca pinnatifida*	W. Hislop.
430.	*Thunbergia grandiflora* **B**	M. C. Cooke.
431.	*Thunbergia grandiflora*	W. Hislop.
432.	*Trapa bispinosa* **B**	M. C. Cooke.
433.	,, ,, ...	G. E. Quick.
434.	*Triticum aestivum*, Wheat	W. Hislop.
435.	*Typha*, Bulrush	,,
436.	*Zamia spiralis* **B**	M. C. Cooke.
437.	*Zea mays*, Maize	G. E. Quick.
438.	*Zea mays*, Maize **B**	M. C. Cooke.
439.	*Zingiber officinale*, Ginger **B**	,,

Sect. D.—CRYPTOGAMIA.

1. Ferns.

D.		
1.	Hairs from Fern	S. J. McIntire.
2.	Hairs of Fern Leaf **B**	J. F. Pickard.
3.	Scalariform Tissue from *Pteris aquilina* **B** ...	J. D. Jackson.
4.	,, ,, ,, **B** ...	N. Burgess.
5.	Scales of Hart's Tongue	G. E. Quick.
6.	Section (oblique) of *Pteris aquilina* **B**	N. Burgess.
7.	Sori of *Acrophorus hispidus*	M. C. Cooke.
8.	,, *Adiantopsis radiata*	,,
9.	,, *Adiantum cristatum*	,,
10.	,, *Adiantum hispidulum*	,,
11.	,, *Adiantum lucidum*	,,
12.	,, *Adiantum lunulatum*	,,
13.	,, *Adiantum pedatum*	,,
14.	,, *Adiantum prionophyllum*	,,
15.	,, *Alsophila australis*	,,
16.	,, *Amphicomia Guayanensis*	,,
17.	,, *Amphidesmium blechnoides*	,,
18.	,, *Anapeltis sqamulosa*	,,
19.	,, *Anchistea virginea*	,,
20.	,, *Asplenium*	R. T. Lewis.
21.	,, *Asplenium ebenum*	M. C. Cooke.
22.	,, *Asplenium flabelliferum*	R. T. Lewis.
23.	,, *Asplenium marinum*	,,

D.			Donor.
24.	Sori of	*Asplenium nitens*	M. C. Cooke.
25.	,,	*Athyrium asplenoides*	,,
26.	,,	*Athyrium axillare*	,,
27.	,,	*Balantium coniifolium*	,,
28.	,,	*Bathmium trifoliatum*	,,
29.	,,	*Blechnum occidentale*	,,
30.	,,	*Blechnum striatum*	,,
31.	,,	*Callipteris prolifera*	,,
32.	,,	*Campyloneurum repens*	,,
33.	,,	*Campteria leptophylla*	,,
34.	,,	*Cardiochlæna macrophylla*	,,
35.	,,	*Cereopteris ochracea*	,,
36.	,,	*Cereopteris pulchella*	,,
37.	,,	*Ceterach officinarum*	R. T. Lewis.
38.	,,	*Cheilanthes fragrans*	M. C. Cooke.
39.	,,	*Cheilanthes trichomanoides*	,,
40.	,,	*Cibotium assamicum*	,,
41.	,,	*Cibotium Barbara*	R. T. Lewis
42.	,,	*Cibotium Schiedii*	,,
43.	,,	*Cionidium Moorei*	,,
44.	,,	,, ,, ...	M. C. Cooke.
45.	,,	*Colysis membranacea*	,,
46.	,,	*Coniogramma serrulata*	,,
47.	,,	*Culcita macrocarpa*	,,
48.	,,	*Cyathea canaliculata*	,,
49.	,,	*Cyathea dealbata*	R. T. Lewis.
50.	,,	*Cyathea medullaris*	M. C. Cooke.
51.	,,	*Cyathea serra*	,,
52.	,,	*Cyrtomium*	R. T. Lewis.
53.	,,	*Cyrtomium anomophyllum*	A. C. Cole.
54.	,,	*Cyrtomium anomophyllum*	M. C. Cooke.
55.	,,	*Cyrtomium falcatum*	,,
56.	,,	*Darea dimorphum*	,,
57.	,,	*Darea diversifolia*	,,
58.	,,	*Darea inæqualis*...	,,
59.	,,	*Darea rutæfolia*...	,,
60.	,,	*Darea vivipara*...	,,
61.	,,	*Davallia bullata*	,,
62.	,,	*Davallia canariensis*	H. F. Hailes.
63.	,,	*Davallia canariensis*	M. C. Cooke.
64.	,,	*Davallia elegans*	,,
65.	,,	*Davallia solida*	,,
66.	,,	*Dennstadtia punctilobula*	,,
67.	,,	*Dennstadtia scabra*	,,
68.	,,	*Deparia prolifera*	,,
69.	,,	*Diacalpe aspinoides*	,,
70.	,,	*Dicksonia selloviana*	,,
71.	,,	*Dicksonia squarrosa*	,,
72.	,,	*Dictyoxiphium panamense*	,,
73.	,,	*Diplazium decussatum*	,,
74.	,,	*Diplazium striatum*	,,

D.			Donor.
75.	Sori of	*Doodya aspera*	M. C. Cooke.
76.	,,	*Doodya caudata*	,,
77.	,,	*Doryopteris sagittæfolia*	,,
78.	,,	*Elaphoglossum squamosum*	W. M. Bywater.
79.	,,	*Goniophlebium catharina*	M. C. Cooke.
80.	,,	*Goniopteris crenata*	,,
81.	,,	*Gymnogramma chrysophylla*	R. T. Lewis.
82.	,,	*Gymnogramma Mertensii*	M. C. Cooke.
83.	,,	*Hemidictyum marginatum*	,,
84.	,,	*Hemitelia horrido*	,,
85.	,,	*Hemitelia petiolata*	,,
86.	,,	*Heterophlebium grandifolium*	,,
87.	,,	*Hymenophyllum*	R. T. Lewis.
88.	,,	*Hymenostegia speciosa*	M. C. Cooke.
89.	,,	*Hypodematium omestum*	,,
90.	,,	*Hypolepis*	R. T. Lewis.
91.	,,	*Hypolepis tenuifolia*	M. C. Cooke.
92.	,,	*Lastrea cochleata*	,,
93.	,,	*Lastrea marginata*	,,
94.	,,	*Lastrea patens*	,,
95.	,,	*Lepichosma marantæ*	,,
96.	,,	*Leptogramma gracilis*	,,
97.	,,	*Leptopteris hymenophylloides*	,,
98.	,,	*Leucostegia pulchra*	,,
99.	,,	*Lindsaya flabellata*	,,
100.	,,	*Lomaria discolor*	,,
101.	,,	*Lomaria fraxinea*	,,
102.	,,	*Lomaria lanceolata*	,,
103.	,,	*Lomaria Patersonii*	,,
104.	,,	*Lonchitis pubescens*	,,
105.	,,	*Loniopteris tetragona*	,,
106.	,,	*Lophosoria pruinata*	,,
107.	,,	*Loxoscaphe gibberosa*	,,
108.	,,	*Lygodium volubile*	,,
109.	,,	*Marattia alata*	,,
110.	,,	*Meniscium sorbifolium*	,,
111.	,,	*Mertensia dichotoma*	,,
112.	,,	*Microlepis hirsuta*	,,
113.	,,	*Microlepis lonchitoidea*	,,
114.	,,	*Microsorium irioides*	,,
115.	,,	*Nephrodium malle*	,,
116.	,,	*Nephrolepis davallioides*	,,
117.	,,	*Nephrolepis tuberosa*	,,
118.	,,	*Neurogramma rufa*	,,
119.	,,	*Niphobolus lingua*	,,
120.	,,	*Nothochlæna chrysophylla*	,,
121.	,,	*Nothochlæna nivea*	,,
122.	,,	*Nothochlæna trichomanoides*	,,
123.	,,	*Ochropteris pallens*	,,
124.	,,	*Odontoloma Boryanum*	,,
125.	,,	*Onoclea sensibilis*	,,

D.		Donor.
126.	Sori of *Pellæa hastata*	M. C. Cooke.
127.	,, *Peranema cyathoides*	,,
128.	,, *Phlebodium pitherulentum*	,,
129.	,, *Phlegopteris caudata*	,,
130.	,, *Phlegopteris hexagonoptera*	,,
131.	,, *Physematium obtusum*	,,
132.	,, *Platycerium alcicorne*	,,
133.	,, *Platycerium alcicorne*	W. M. Bywater.
134.	,, *Polypodium*	R. T. Lewis.
135.	,, *Polypodium Billardieri*	,,
136.	,, *Polypodium simile*	M. C. Cooke.
137.	,, *Polystichum capense*	,,
138.	,, *Pteris tremula*	,,
139.	,, *Saccoloma elegans*	,,
140.	,, *Sagenia pteropus*	,,
141.	,, *Schizoloma Brunonis*	,,
142.	,, *Schizoloma ensifolium*	,,
143.	,, *Scyphularia pentaphylla*	,,
144.	,, *Stenoloma clavatum*	,,
145.	,, *Stenoloma tenuifolium*	,,
146.	,, *Symopteris Sielsoldii*	,,
147.	,, *Tarachia falcata*	,,
148.	,, *Tarachia præmorsa*	,,
149.	,, *Thamnopteris Australasiæ*	,,
150.	,, *Thelypteris Noveboracensis*	,,
151.	,, *Todea barbara*	,,
152.	,, *Todea hymenophylloides*	R. T. Lewis.
153.	,, *Trichomanes rigidum*	M. C. Cooke.
154.	,, *Trichopteris excelsa*	,,
155.	,, *Woodsia rufidula*	,,
156.	,, *Woodwardia*	R. T. Lewis.
157.	,, *Woodwardia radicans*	M. C. Cooke.
158.	Spores of *Polystichum angulare*	G. E. Quick.
159.	Stomata of Fern	J. A. Archer.
160.	Spores of *Equisetum*	S. J. McIntire.
161.	,, *Isöetes velata*	M. C. Cooke.

2. Mosses.

162.	Bog Moss, *Sphagnum*	S. J. McIntire.
163.	,, *Sphagnum cymbifolium* **B**	M. C. Cooke.
164.	,, *Sphagnum*	Mr. Moginie.
165.	Liver Wort, *Blasia pusilla*	Mr. Jackson.
166 to 168.	Moss Capsules	Mr. Smith.
169.	Peristome of *Funaria hygrometrica*	Mr. Oxley.

3. Fungi.

170.	*Aregma bulbosum*, Bramble brand **B**	Mr. Bennett.
171.	*Aregma bulbosum* **B**	M. C. Cooke.
172.	*Aregma bulbosum*	W. M. Bywater.
173.	*Aregma gracile* **B**	T. C. White.
174.	*Aregma mucronatum* **B**	M. C. Cooke.

D.		Donor.
175.	*Aregma mucronatum*, Rose brand **B**	G. E. Quick.
176.	*Aregma obtusatum* **B**	M. C. Cooke.
177.	*Arthrobotryum atrum* **B**	„
178.	*Aspergillus candidus*	„
179.	*Asterosporium Hoffmanni*	W. M. Bywater.
180.	*Botryosporium diffusum*	M. C. Cooke.
181.	*Chaetomium chartarum*	„
182.	*Coryneum disciforme* **B**	„
183.	*Dactylium roseum*	„
184.	*Helminthosporium folliculatum* **B**	„
185.	*Helminthosporium Smithii* **B**	„
186.	*Nectria cinnabarina*	„
187.	*Polyactis cinerea*	„
188.	*Polycystis pompholygodes*	W. M. Bywater.
189.	*Puccinia aculeata* **B**	M. C. Cooke.
190.	*Puccinia ægopodii* **B**	„
191.	*Puccinia anemones* **B**	„
192.	*Puccinia apii* **B**	„
193.	*Puccinia arundinacea* **B**	„
194.	*Puccinia asari* **B**	„
195.	*Puccinia asparagi* **B**	„
196.	*Puccinia betonicæ* **B**	G. E. Quick.
197.	*Puccinia betonicæ* **B**	M. C. Cooke.
198.	*Puccinia calthæ* **B**	„
199.	*Puccinia campanulæ* **B**	„
200.	*Puccinia circææ* **B**	„
201.	*Puccinia coronata*	W. M. Bywater.
202.	*Puccinia difformis* **B**	M. C. Cooke.
203.	*Puccinia discoidearum* **B**	„
204.	*Puccinia graminis* **B**	„
205.	*Puccinia lychnidearum* **B**	„
206.	*Puccinia luzulæ* **B**	„
207.	*Puccinia nolitangeris* **B**	„
208.	*Puccinia primulæ* **B**	„
209.	*Puccinia prunorum*	W. M. Bywater.
210.	*Puccinia smyrnii* **B**	M. C. Cooke.
211.	*Puccinia thesii* **B**	„
212.	*Puccinia tragopogi* **B**	„
213.	*Puccinia veronicarum* **B**	„
214.	*Puccinia virgaureæ* **B**	„
215.	*Ræstelia lacerata* (Spores) **B**	„
216.	*Sphæria fimbriata*	„
217.	*Sphæria herbarum*	„
218.	*Stemonitis ferruginea* **B**	„
219.	*Stemonitis fusca*	W. M. Bywater.
220.	*Thecaphora hyalina* **B**	M. C. Cooke.
221.	*Tilletia caries* **B**	„
222.	*Trichia chrysosperma* **B**	„
223.	*Trichia clavata* **B**	„
224.	*Trichia fallax* **B**	„
225.	*Trichia Neesiana* **B**	„

D.		Donor.
226.	*Trichia ovata* **B**	M. C. Cooke.
227.	*Trichia pyriformis* **B**	"
228.	*Trichia varia* **B**	"
229.	*Trichobasis fabæ*	T. C. White.
230.	*Trichobasis rubigo-vera*	"
231.	*Trichobasis seneccionis*	"
232.	*Trichobasis senecionis*	"
233.	*Trichobasis violarum* **B**	"
234.	*Triphragmium ulmariæ* **B**	G. E. Quick.
235.	*Triphragmium ulmariæ* **B**	M. C. Cooke.
236.	*Uncinula bicornis*	"
237.	*Uncinula polychaeta* (U. States)...	"
238.	*Ustilago maydis* **B**	"
239.	*Xenodochus carbonarius* **B**	"

4. Characeæ.

240.	*Chara medicaginula* (Fossil)	H. F. Hailes.

5. Algæ.

241.	*Arthrocladia villosa*	C. Adcock.
242.	*Bonnemaisonia asparagoides*	"
243.	*Callithamnion*, tetraspores	"
244.	*Callithamnion arbuscula* **B**	H. A. Smith.
245.	*Callithamnion floccosum* **B**	"
246.	*Callithamnion pedicellatum*	C. Adcock.
247.	*Callithamnion roseum* **B**	H. A. Smith.
248.	*Ceramium* (favellæ)	C. Adcock.
249.	*Ceramium*	"
250.	*Ceramium acanthonotum* **B**	H. A. Smith.
251.	*Chorda filum*	C. Adcock.
252.	*Cladostephus verticellatus*	"
253.	*Dasya arbuscula* **B**	H. A. Smith.
254.	*Dasya venusta*	C. Adcock.
255.	*Dasya venusta*	"
256.	*Delesseria*	"
257.	*Delesseria alata* **B**	H. A. Smith.
258.	*Desmarestia viridis* **B**	"
259.	*Dictyota dichotoma*	C. Adcock.
260.	*Dumontia filiformis*	"
261.	*Ectocarpus Mertensii* **B**	H. A. Smith.
262.	*Griffithsia barbata*	C. Adcock.
263.	*Griffithsia corallina*	"
264.	*Griffithsia setacea*, tetraspores	"
265.	*Laurencia tenuissima* (Spores)	"
266.	*Padina pavonia*	"
267, 268.	*Plocamium coccineum*	"
269.	*Plocamium coccineum* **B**	H. A. Smith.
270.	*Polysiphonia*	C. Adcock.
271.	*Polysiphonia urceolata* **B**	H. A. Smith.
272.	*Protococcus nivalis* **B**	B. W. Richardson.

D.		Donor.
273, 274.	*Ptilota elegans* **B**	H. A. Smith.
275.	*Ptilota plumosa* **B**	,,
276.	*Ptilota plumosa*...	G. Paton.
277.	*Rhodomela subfusca* (?)	C. Adcock.
278.	*Sphærococcus coronopifolius*	,,
279.	*Sporochnus pedunculatus*	,,
280.	*Stilophora rhizodes*	,,

6. Desmids.

281.	*Micrasterias and Euastrum* **B**	G. Paton.
282.	*Micrasterias and Closterium* **B**	,,

7. Diatoms.

283.	*Actinocyclus* **B**	Mr. Hardman.
284, 285.	*Actinocyclus subtilis* **B**...	H. F. Hailes
286.	*Actinocyclus subtilis*	B. Taylor.
287.	*Actinocyclus undulatus*	F. Kitton.
288.	*Amphiprora conspicua*	,,
289.	*Amphiprora ornata* *Orthosira punctato* ,, *orichalcea*	,,
290.	*Amphora constricta* **B**	T. Curties.
291.	*Amphora ornata* **B**	,,
292.	*Amphora ovalis* **B**	W. W. Reeves.
293.	*Arachnoidiscus Ehrenbergii* **B**	J. Russell.
294.	*Arachnoidiscus Ehrenbergii*, in situ	A. C. Cole.
295.	*Asterolampra* (various)	,,
296.	*Aulacodiscus angulatus* **B**	Mr. Hardman.
297.	*Aulacodiscus orientalis* **B**	,,
298.	*Auliscus sculptus* **B**	,,
299.	*Biddulphia aurita*	F. Kitton.
300.	*Biddulphia lævis* **B**	A. de Brebisson.
301.	*Biddulphia reticulata* **B**	Mr. Hardman.
302.	*Campylodiscus clypeus* **B**...	M. C. Cooke.
303.	*Campylodiscus clypeus* **B**...	H. F. Hailes.
304.	*Campylodiscus clypeus*	F. Kitton.
305.	*Campylodiscus undulatus* **B**	Mr. Hardman.
306.	*Cerataulus turgidus* **B**	,,
307.	*Cestodiscus* **B**	,,
308.	*Chaetoceros Wighamii* (frustules)	F. Kitton.
309.	*Chaetoceros Wighamii* *Navicula tumens* *Epithemia ventricosum*	,,
310.	*Cocconeis* **B**	T. Curties.
311.	*Cocconeis Grevillei* **B**	Mr. Hardman.
312.	*Cocconema Mexicana* **B**	Exchange.
313.	*Cyclotella operculata* **B**	T. Curties.
314.	*Cyclotella punctata* **B**	,,
315.	*Cyclotella rectangula* **B**	A. de Brebisson.
316.	*Cymatopleura apiculata* **B**	,,
317.	*Denticulata sinuata* **B**...	T. Curties.
318.	*Diatoma vulgare* **B**	,,
319.	*Epithemia ocellata* **B**	,,

D.		Donor.
320.	*Epithemia succincta* **B**	A. de Brebisson.
321.	*Eupodiscus* **B**	T. Curties.
322.	*Eupodiscus argus* **B**	W. W. Reeves.
323.	*Eupodiscus Gregorianus* **B**	A. de Brebisson.
324.	*Eupodiscus Ralfsii* **B**	J. Russell.
325.	*Eupodiscus Rogersii* **B**...	T. Curties.
326.	*Eupodiscus Roperi* **B**	A. de Brebisson.
327.	*Eupodiscus subtilis* **B**	,,
328.	*Fragilaria crotonensis* (N. Y.)	F. Kitton.
329.	*Fragilaria crotonensis* (S. V.) *Cyclotella rotula*	,,
330.	*Fragilaria virescens* **B**...	A. de Brebisson.
331.	*Gambella gastroides* **B**...	T. Curties.
332.	*Gomphonema* **B**	Exchange.
333.	*Gomphonema et Synedra* **B**	B. Taylor.
334.	*Gomphonema capitatum* *Gomphonema constrictum* } on one stipe ...	F. Kitton.
335.	*Gomphonema geminatum*	P. Gray.
336.	*Grammatophora macilenta* **B**	G. Paton.
337.	*Grammatophora marina* **B**	,,
338.	*Heliopelta* **B**	J. Russell.
339.	*Heliopelta et E. Rogersii* **B**	T. Curties.
340.	*Hyalodiscus subtilis* **B**...	Mr. Hardman.
341.	*Isthmia* (unnamed)	A. C. Cole.
342.	*Isthmia nervosa*	Dr. Dempsey.
343.	*Melosira* **B**	G. Paton.
344.	*Melosira Borreri* **B**	M. C. Cooke.
345.	*Melosira nummuloides* **B**	T. C. White.
346.	*Navicula bacillum*	F. Kitton.
347.	*Navicula bullata* **B**	T. Curties.
348.	*Navicula dactylus* **B**	A. de Brebisson.
349.	*Navicula elegans* *Pinnularia peregrina*	F. Kitton.
350.	*Navicula granulata* **B**...	T. Curties.
351.	*Navicula Hartleyana*	Mr. Tatem.
352.	*Navicula humerosa* **B**	A. de Brebisson.
353.	*Navicula lyra* **B**	Mr. Hardman.
354.	*Navicula oculata* **B**	A. de Brebisson.
355.	*Navicula prætexta* **B**	Mr. Hardman.
356-361.	*Navicula punctata* **B**	A. de Brebisson.
362.	*Navicula punctata*	F. Kitton.
363.	*Navicula rhomboides*	H. A. Smith.
364.	*Navicula serians*	F. Kitton.
365.	*Navicula sphærophora*	,,
366.	*Navicula splendida et pandura* **B**	Mr. Hardman.
367.	*Navicula vitræa*, Greville	F. Kitton.
368.	*Nitzschia Brebissonii* **B**	A. de Brebisson.
369.	*Nitzschia gracilenta* **B**	,,
370.	*Nitzschia obtusa* **B**	,,
371.	*Nitzschia plicata* **B**	T. Curties.
372.	*Odontidium et Fragilaria* **B**	Exchange.

D.		Donor.
373.	*Peronia erinacea* **B**	A. de Brebisson.
374, 375.	*Pinnularia*, &c. **B**	B. Taylor.
376.	*Pinnularia cardinalis*	F. Kitton.
377.	*Pinnularia Hartleyana* **B**	T. Curties.
378.	*Pinnularia nobilis* **B**	„
379.	*Pinnularia viridis* **B**	B. Taylor.
380.	*Pleurosigma angulata* **B**	„
381.	„ *balticum* ·002	Dr. Dempsey.
382.	„ *balticum* ·003	„
383.	„ *balticum* ·003	„
384.	„ *balticum* „ *strigosum*	F. Kitton.
385.	„ *elongatum*	„
386.	„ *estuarii* **B**	A. de Brebisson.
387.	„ *estuarii* **B**	B. Taylor.
388.	„ *formosum* **B**	„
389.	„ *formosum* **B**	H. F. Hailes.
390.	„ *formosum*	„
391.	„ *formosum* „ *balticum* „ *strigosum* „ *decorum* „ *quadratum* „ *angulatum* „ *hippocampus* „ *lacustre* „ *acuminatum* „ *scalprum*	Dr. Dempsey.
392.	„ *gracilentum* **B**	A. de Brebisson.
393.	„ *hippocampus*	Dr. Dempsey.
394.	„ *lacustris* **B**	T. Curties.
395.	*Polymyxos coronalis* **B**	Mr. Hardman.
396.	„ *coronatus* **B**	T. Curties.
397.	*Rhabdonema* **B**	T. C. White.
398.	„ *arcuatum*	F. Kitton.
399.	„ *Crozieri* **B**	M. C. Cooke.
400.	„ *minutum*	F. Kitton.
401.	*Solium* **B**	T. Curties.
402-405.	*Stauroneis acuta* **B**	„
406.	*Stauroneis phœnicenteron* **B**	„
407.	*Stictodiscus?*	A. C. Cole.
408.	*Surirella Capronii* *Surirella elegans* *Surirella biseriata* **B**	A. de Brebisson.
409.	*Surirella constricta*	F. Kitton.
410, 411.	*Surirella crumena* **B**	A. de Brebisson.
412.	*Surirella linearis* *Surirella amphioxys* **B**	„
413.	*Surirella minuta* **B**	„
414.	*Surirella ovalis* **B**	T. Curties.
415, 416.	*Surirella subsalsa, var rotundata* **B**	A. de Brebisson.

D.		*Donor.*
417, 418.	*Synedra longissima* **B**	T. Curties.
419.	*Synedra ulna* **B**	Exchange.
420.	{ *Synedra undulata* { *Rhabdonema adriaticum* }	F. Kitton.
421.	*Tabellaria* **B**	T. Curties.
422.	*Toxonidea Gregoriana* **B**	B. Taylor.
423.	*Triceratium* **B**	Mr. Hardman.
424.	*Triceratium* (unnamed)	A. C. Cole.
425.	*Triceratium arcticum*	F. Kitton.
426.	*Triceratium brachiatum*	A. C. Cole.
427.	{ *Triceratium exiguum* { *Orthosira punctata* { *Navicula scutelloides* }	F. Kitton.
428.	*Triceratium grande* **B**	Mr. Hardman.
429.	*Triceratium turratella*...	A. C. Cole.
430.	Deposit Bilin **B**	W. W. Reeves.
431.	,, Chalk Pond, Beddington **B**	Exchange.
432, 433.	,, Cherryfield, Maine **B**	M. C. Cooke.
434.	,, Cochin, E. I. **B**	T. Curties.
435.	,, Cochin, E. I. **B**	,,
436, 437.	,, Colseed Bay, U. S. **B**	M. C. Cooke.
438.	,, Columbus, Ohio **B**	T. Curties.
439, 440.	,, Cornwallis, Nova Scotia **B**	M. C. Cooke.
441, 442.	,, Coswig, on the Elbe **B**...	,,
443.	,, Duck Pond, Waterford **B**	Exchange.
444, 445.	,, Ebstorf, Hanover **B**	M. C. Cooke.
446, 447.	,, Eger, Bohemia **B**	,,
448.	,, Eisen **B**	G. Paton.
449, 450.	,, Franzensbad, Bohemia **B**	M. C. Cooke.
451.	,, French's Pond, Maine **B**	Exchange.
452.	,, Gossa, Bohemia **B**	W. W. Reeves.
453, 454.	,, Gowan's Bay, N. Y. **B**	M. C. Cooke.
455, 456.	,, Ipswich, Mass. **B**	,,
457, 458.	,, Laconia, N.H. **B**	,,
459, 460.	,, Monmouth, Maine **B**	,,
461, 462.	,, Monticello, N. Y. **B**	,,
463, 464.	,, North Providence **B**	,,
465.	,, Nottingham, U. S. **B**	B. Taylor.
466.	,, Nottingham, Maryland **B**	Exchange.
467, 468.	,, Oberhohe, Hanover **B**	M. C. Cooke.
469.	,, Peat Bog, N. Bridgton **B**	Exchange.
470, 471.	,, Perley's Meadow, Bridgton **B**	M. C. Cooke.
472.	,, Peruvian Guano	B. Taylor.
473, 474.	,, Richmond, on the Potomac **B**	M. C. Cooke.
475, 476.	,, Salem, Mass. **B**	,,
477, 478.	,, Salt Lake Desert **B**	,,
479.	,, Sandwich Islands **B**	T. Curties.
480, 481.	,, Sing-Sing, Hudson's River **B**	M. C. Cooke.
482.	,, Seville **B**	T. Curties.
483, 484.	,, S. Bridgton, Maine **B**	Exchange.
485.	,, Subpeat, N. Bridgton, Maine **B** ...	,,

D.		Donor.
486.	Deposit Toome Bridge **B**	B. Taylor.
487, 488.	„ Watermouth Caverns **B**	T. Curties.
489.	„ West Point, N. Y. **B**	G. Paton.
490.	Dredgings, Atlantic Cable, 1865	C. Collins.
491.	„ Bay of Bengal **B**	B. Taylor.
492-496.	„ Loch Fine **B**	T. Curties.
497.	„ Loch Fine **B**	„
498, 499.	Fossil Diatomaceæ **B**	W. W. Reeves.
500.	„ **B**	B. Taylor.
501, 502.	Mixed Diatoms **B**	Mr. Hardman.
503-509.	„ **B**	T. Curties.
510-516.	„ **B**	„
517.	„	A. C. Cole.
518.	„ from Corsican Algæ **B**	B. Taylor.
519.	„ „ Edinburgh **B**	B. Taylor.
520.	„ „ Hants	J. W. Meacher.
521.	„ „ Market Weighton Canal **B**...	T. Curties.
522.	„ „ New Zealand	W. Hainworth.
523.	„ „ Perthshire **B**	T. Curties.
524.	„ „ Spring, N. Bridgton **B** ...	Exchange.
525.	„ „ Stoneyford River **B** ...	B. Taylor.
526-528.	Siliceous vesicles of Max Schultze, illustrative of Diatom structure	J. H. Hennah.
529.	Unnamed Diatoms	A. C. Cole.
530.	„ „	„
531.	„ „	„

MINERAL.

E.		
1.	Acid—Aspartic	Dr. Dempsey.
2.	„ Boracic	G. E. Quick.
3, 4.	„ Hippuric	T. C. White.
5.	„ Hippuric	G. E. Quick.
6-21.	„ Hippuric	W. Hislop.
22.	„ Hippuric, artificial	T. C White.
23-24.	„ Pyrogallic	W. H. Golding.
25.	„ Tartaric...	E. Marks.
26.	„ Uric	Mr. Oxley.
27-30.	Ammonia, Borate	Mr. Conder.
31.	Ammonia, nitrate of	G. E. Quick.
32.	Avanturine	„
33.	Barium, chloride of	
34.	Calcareous Egg Sand	Mr. Simson.
35.	Coal Ash	C. Collins.
36.	Coal section	A. Topping.
37.	Copper, crystallized	H. T. Hailes.
38.	„ pyrites	M. C. Cooke.
39.	„ sulphate of	E. Marks.
40, 41.	„ sulphate	W. H. Golding.

E.		Donor.
42.	Copper, sulphate 75°	Mr. Martin.
43.	„ sulphate 85°	„
44.	„ sulphate 100°	„
45-47.	„ sulphate	W. Hislop.
48.	„ sulphate, fine spirals	„
49.	Coprolite, section	T. C. White.
50.	Fossil Plant from Coal Measures	J. Butterworth.
51.	Gem sand (Ava)	M. C. Cooke.
52.	Gold, native, from Alexander	T. Ross.
53.	„ Ballarat	„
54.	„ Brazil	„
55.	„ California	„
56.	„ Cape Coast	„
57.	„ Caucasus	„
58.	„ Chili	„
59.	„ Geelong	„
60.	„ Golconda	„
61.	„ Gold Coast	„
62.	„ Guadalquiver	„
63.	„ Guinea	„
64.	„ Hartz Mountains	„
65.	„ Mexico	„
66.	„ Nepal	„
67.	„ Persia	„
68.	„ Peru	„
69.	„ Transylvania	„
70.	„ Ural Mountains	„
71.	„ Wicklow	„
72.	Gold crystallized from Ammonia Iodide	W. H. Golding.
73, 74.	Granite (section) from Mt. Sinai **B**	Mr. Kibble.
75.	Heliotrope, or Bloodstone	H. F. Hailes.
76, 77.	Iron, sulphate of	W. H. Golding.
78.	Magnesia, sulphate of	G. E. Quick.
79.	„ „	W. H. Golding.
80.	Magnesia, sulphate	A. Topping.
81, 82.	Malachite	J. Bockett.
83.	Marble (Ephesus) **B**	Mr. Simson.
84.	Meteoric stone	R. T. Lewis.
85.	Nickel, sulphate of	G. E. Quick.
86.	Norway Rock, section **B**	G. Paton.
87.	Opal	J. Bockett.
88.	Porphyrine, section **B**	G. Paton.
89.	Potass Bichromate	W. H. Golding.
90.	Potash, chlorate	J. W. Groves.
91.	Patash, nitrate of	G. E. Quick.
92.	Potassium Ferrocyanide...	W. N. Golding.
93.	Quartz crushed...	W. Moginie.
94.	Salicine	J. F. Pickard.
95.	Salicine	A. Topping.
96.	Salt work Crystals, Bergkrystalle	Herr Weisflog.
97.	„ Eisenglimmer	„

E.		*Donor.*
98.	Salt work Crystals, Gelbe Krystalle	Herr Weisflog.
99.	,, Blauschwarze Krystalle ...	,,
100.	,, Flocken und Faden	,,
101.	,, Schwefelkies...	,,
102-105.	Santonine	W. Hislop.
106-109.	Santonine	,,
110-113.	Sections of Stone **B**	G. Paton.
114.	Silicon	J. W. Leakey.
115.	Silver, crystallized	A. Topping.
116.	Silver, native (Peru)	J. W. Leakey.
117.	Soda, Acetate of	W. H. Golding.
118.	Theine from Black Tea	,,
119.	Titanium	J. Bockett.
120.	Uranium, nitrate of	W. H. Golding.
121.	Wood, fossil (Tasmania)	J. Bockett.

Miscellaneous.

122-124.	Ancient glass from Temple of Venus (Cyprus) ...	R. T. Lewis.
125.	,, disintegrated, from the Catacombs, Rome	C. Baker.
126.	Dendritic spot on paper	M. C. Cooke.
127 to 132.	Illustrations of Mr. R. T. Lewis' paper, on some of the Microscopic Effects of the Electric Spark. Sept. 28, 1866.	R. T. Lewis.
133.	Microphotograph, "The Times"...	G. Paton.
134.	,, from a picture...	,,
135.	,, Lord Raglan's Tablet	,,
136.	,, "The Rent Day"	,,
137.	,, "The Return"	,,
138.	,, "The Last Appeal"	,,
139.	Microscopic Writing, "The Lord's Prayer." ·0004.	Capt. St. John.

G. P. BACON, LEWES.

SEVENTH REPORT

OF THE

QUEKETT MICROSCOPICAL CLUB,

AND

LIST OF MEMBERS.

Meeting at University College, London, on the Second and Fourth Fridays of every Month at Eight o'clock.

Offices: 192, PICCADILLY,
LONDON.

July 1872.

(*Extract from original Prospectus, July* 1865.)

"The want of such a Club as the present has long been felt, wherein " Microscopists and students with kindred tastes might meet at stated periods " to hold cheerful converse with each other, exhibit and exchange specimens, " read papers on topics of interest, discuss doubtful points, compare notes of " progress, and gossip over those special subjects in which they are more or " less interested: where, in fact, each member would be solicited to bring his " own individual experience, be it ever so small, and cast it into the treasury " for the general good. Such are some of the objects which the present Club " seeks to attain. In addition thereto it hopes to organize occasional Field " Excursions, at proper seasons, for the collection of living specimens, to " acquire a Library of such books of reference as will be most useful to " enquiring students; and, trusting to the proverbial liberality of Micro- " scopists, to add thereto a comprehensive Cabinet of Objects. By these, and " similar means, the Quekett Microscopical Club seeks to merit the support " of all earnest men who may be devoted to such pursuits; and, by fostering " and encouraging a love for Microscopical studies, to deserve the approval " of men of science and more learned societies."

OFFICERS AND COMMITTEE.

(Elected July 1872.)

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DR. ROBERT BRAITHWAITE, F.R.M.S., F.L.S.

Vice-Presidents.

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ARTHUR E. DURHAM, F.R.C.S., F.R.M.S.
HENRY LEE, F.L.S., F.R.M.S.
DR. MATTHEWS.

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M. C. COOKE, M.A.

Hon. Reporter.

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CHARLES F. WHITE, F.R.M.S.
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THOMAS GREENISH, F.R.M.S.
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W. T. SUFFOLK, F.R.M.S.
F. OXLEY.

Exchange (of Slides) Committee.

H. F. HAILES.
E. MARKS.

PAST PRESIDENTS.

	Elected
EDWIN LANKESTER, M.D., F.R.S. - - -	July, 1865.
ERNEST HART - - - - - - -	„ 1866.
ARTHUR E. DURHAM, F.L.S., &c. - - - -	„ 1867.
„ „ - - - -	„ 1868.
PETER LE NEVE FOSTER, M.A. - - - -	„ 1869.
LIONEL S. BEALE, M.B., F.R.S., &c. - - -	„ 1870.
„ „ - - - -	„ 1871.

REPORT OF THE COMMITTEE.

THE Committee of the Quekett Microscopical Club, in offering their Seventh Annual Report to its Members, have much pleasure in announcing that during the past year the progress of the Club has been satisfactory, and its success continuous.

Looking to the fact that three kindred societies have been established in the suburbs of this Metropolis, they might have expected a diminution in the number of its Members, but they see with pleasure that the numerical strength of the Club remains undiminished, while its work and objects are carried out as energetically as ever; they are happy also in saying that a cordial co-operation exists between what may be regarded as the parent society and its several offshoots, and your Committee trust that this feeling may be as lasting and as warm as such a feeling should be amongst those who find a bond of union in kindred tastes and pursuits.

Your Committee would again take this opportunity of tendering their thanks to the Authorities of University College, who—with their accustomed liberality—still allow the Club the invaluable privilege of meeting twice each month within its precincts rent free; and while thanking these gentlemen on their own behalf for courteous accessions

to their wishes on several occasions, the Committee feel they but express the sentiments felt by the Members generally.

The Meetings of the Club still continue well attended, and your Committee cannot be insensible to the appreciation of the Gossip Night on the *second* Friday in each month, as manifested in an increased and an increasing attendance; and they would especially call the attention of the younger Members, and of those to whom Microscopy is a new pursuit, to the inestimable advantages offered by this night, for in addition to the exhibition of many interesting mounted specimens, some of which are not to be obtained through the ordinary channels, microscopic life is also well represented, and such details afforded to beginners as may enable them to procure such for themselves—while the wants of the rising botanist or geologist will find those particular departments of science not unrepresented on this occasion; added to which a vast amount of useful information, relative to microscopical manipulation and the mounting and preservation of specimens, is gathered from the social and kindly chat which takes place at this Meeting.

The subjects of the Papers read at the ordinary Meetings during the past year partake of a varied character, and evince much careful observation.

The following Papers were read, the discussions on which will be found reported in the published Proceedings:—

Mr. M. C. Cooke . . .	On the disappearance of the Nuclei of certain Fern spores after mounting.
Mr. J. W. Waller . . .	On Cliona, or the boring Sponge.
Dr. Lattey	On the Mounting of Marine Polyzoa.

Mr. T. Charters White .	On the Minute Anatomy of the Pulp of a Tooth.
Mr. M. C. Cooke	On the Tremelloid Uredines.
Mr. W. T. Suffolk . . .	Additional remarks on Microscopical delineation.
Mr. James Smith . . .	On Cell Mounting.
Mr. W. H. Furlonge . .	On the Anatomy of Pulex irritans (second paper).
Dr. G. W. Royston Pigott	On a new Method of ascertaining the Magnifying power of Objectives.
Mr. J. G. Waller . . .	Observations on Freshwater Sponges.
Mr. W. H. Furlonge . .	On a Phenomenon of Binocular Vision in the delineation of Microscopical objects.

In addition to these papers many short but interesting communications have been received at the ordinary Meetings, and also various mechanical contrivances, having for their object the facilitation of Microscopical observation, have been exhibited.

During the past year your Committee have been enabled to fulfill the promise made at the last Annual Meeting, and have published Catalogues of the Slides in the Cabinet and of the books in the Library, and they hope by these means to promote a more extended use of these two most important departments of the Club's operations.

By the kindness and liberality of several Members and friends, the following Slides have been added to the Cabinet of the Club since the last Annual Meeting.

Mr. L. Bennett	1
,, M. Burgess	2

Friends, per Mr. Thos. Curties .	50
Dr. A. Lattey	6
Mr. G. Paton	58
„ J. Rogers	12
„ Thos. Rogers	1
„ Topping	24
„ J. G. Waller	6
„ T. C. White	24

Mr. J. Rowlett also presented a 2-inch objective to the Club.

The following additions have been made to the Library during the past year by purchase, and the liberal donations of Members and other gentlemen.

The Smithsonian Annual Reports for 1868–9,
From the Smithsonian Institute, Washington, U.S.
The Hand-book of British Fungi, Part II . Mr. Quick.
Proceedings of the Royal Society for 1870–1 . The Society.
The Invisible World, by Dr. J. Mantell,
Mr. C. C. Bentley.
A Monograph of the Tubularian Hydroids, by Prof. Allman,
By Purchase.

And the Committee would avail themselves of this opportunity of thanking those gentlemen who have presented Books, and the Serial Scientific Literature of the day, to the Library, for what are valued as important acquisitions to the educational advantages of the Club.

The Excursions of the Club still maintain the interest which has attended them from their institution, while a more than usually agreeable character has been imparted to them by the blending together of the Members of the suburban Societies with those of the Club upon these occasions.

The Annual Soirée of the Club was held at University College on March 15th, and invitations were issued to many persons of distinction in Art, Literature, and Science, as well as to the Members. This Conversazione, like those of former years, was well attended, there being about 1,100 Members and visitors present. Upwards of 200 Microscopes were contributed by the Members of the Club, the Croydon Microscopical Society, the Sydenham and Forest Hill Microscopical and Natural History Club, the South London Microscopical Club, and the leading Opticians, the exhibition being thereby rendered unusually attractive. Among many objects of general interest exhibited on this occasion, might be mentioned some fac-simile illuminated drawings of a complete set of ancient jewellery found in the tomb of an Egyptian Queen, and of a date 1800 years B. C., accompanied by translations of the inscriptions found on each piece by Dr. Birch, of the British Museum, kindly lent for exhibition by Mr. E. Kiddle, and some drawings of the Microscopical characters of various tissues, executed most accurately by Mr. Rochfort Connor. The following gentlemen also assisted the Committee by their valuable contributions:—Mr. Apps exhibited some brilliant electrical experiments "in vacuo," Mr. James How, various Photographic views, &c., shown by the Oxy-Calcium Lamp, and Mr. James Martin, of the London Stereoscopic Company, exhibited by the same means some views illustrating South African scenery, the Cape Diamond Fields, and the Livingstone Expedition. Your Committee are pleased to be able to announce that the evening gave satisfaction to all present, and they beg to thank those gentlemen who contributed so ably and largely to bring about this result.

During the past year several resignations have been received from Members in consequence of their removal to the

country, but your Committee feel much pleasure in announcing that, by the addition of new Members, the list still presents over 500 names. They regret to say that an honoured name has been removed by death from the pages of their last report; and other scientific Societies, besides the Quekett Microscopical Club, in which he always took a warm interest, will mourn the loss of Mons. Alphonse de Brebisson.

In concluding this Report your Committee desire to express their thanks to the following gentlemen for their valuable co-operation during the past year; they cannot lightly pass over the services rendered for many years by Mr. Richard T. Lewis as their Honorary Reporter, and they here acknowledge how much the Publishing Committee of the Journal have been indebted to him for his accurate reports of the Proceedings of the Meetings. And they also wish on this occasion to accord their especial thanks to Mr. Edward Jaques, who, from the commencement of the Club has acted as its Honorary Librarian, and whose services they regret they are now compelled to lose; but they feel much satisfaction in being able to announce that they have found his successor in Mr. Alpheus Smith, who for some time past has generously given his services to the Club as its Assistant-Librarian; they also take this opportunity of thanking their honorary Curator, Mr. G. W. Ruffle, for his indefatigable care of the Cabinets of Slides, and to Mr. B. D. Jackson, who has kindly consented to assist him in the issue of Slides to the Members; they feel that their thanks are also due to Messrs. Gay, Oxley, Reeves, and Suffolk, to whose endeavours the organisation of the excursions owe their efficiency; and they also desire to record their obligations to Messrs. Hailes and Marks, the Exchange of Slides Committee, for the satisfactory manner in which they administer this department of the Club. And

they would not omit to acknowledge their obligations to Mr. M. C. Cooke, who, in the midst of much literary work of other kinds, has greatly assisted them in the issue of the Catalogue of the Slides in the Cabinet.

The prospect afforded by a retrospective glance at the progress of the Club during the seventh year of its existence is one that affords the Committee unlimited satisfaction; they see its affairs in every way prosperous, and its numerical strength still maintaining a high position, but more than all, they see its Members working cordially and warmly together in rendering to each and all the information and aid they may severally need; and they feel that while this social and brotherly feeling exists, the Quekett Microscopical Club will continue to retain the support it has always received from its institution.

July 26th, 1872.

ADDRESS OF THE PRESIDENT.

July 26th, 1872.

There is in these days such an insatiable desire to impress upon the world the fact of general progress and improvement, and the vast importance of certain kinds of human knowledge, that there is no little danger of real work of the unpretentious kind being lost in the froth and fuss and hubbub that are made about the tremendous consequences of the mighty discoveries which are about to be made public. It could hardly be otherwise than that our microscopic work should seem unimportant, should suffer in popularity, and should experience neglect at the hands of those who were occupied in researches of such tremendous significance as the origin, formation, properties, and end of worlds. We have, however, been patiently, and, I hope, unremittingly, prosecuting our enquiries,—disturbed neither by the terrible conjectures of the philosophers who have convinced themselves that they are *strong*, nor deterred by the professed indifference of the thinkers who have persuaded themselves that the grand secret of all things is on the eve of being evolved from the contents of a crucible, and about to be so brightly illuminated that the doubts and fears of the patient long expecting multitude are about to be set at rest for ever.

During the past Session we have had several papers of great interest, and many of our discussions have been very instructive. These are recounted in our proceedings, and afford some indication of our activity in the department of research to which we have devoted ourselves. But yet I fear we cannot feel quite sure that we have been as useful as we might have been, or have made the most of the excellent opportunities enjoyed by all members of the Quekett Club. It has often occurred to me as a thing most to be desired that every new method introduced for the demonstration of microscopical structure should be put to the test by some of our most skilful and experienced members, and that specimens illustrating the effects of different methods of investigation should be exhibited at our meetings. In this way the accuracy of original observers would be tested, and science advanced. But undoubtedly the difficulties of carrying out this proposal are considerable, and not to be easily overcome. A student naturally feels that it would be presumptuous on his part to doubt the word of a recognised authority, and he could hardly set to work to test the accuracy of a research without implying that he doubted its truth, which, perhaps, might bring upon him the ridicule of his friends, and would unquestionably expose him to the hostility of many authorities who love truth, but at the same time particularly respect the opinions they entertain.

Every man who devotes himself to any branch of scientific investigation ought to submit to be questioned, and to have his observations repeated and thoroughly tested by others. He who loves science will be the last to display impatience of analytical criticism. He cheerfully encourages re-investigation of everything he has done, instead of proclaiming the intensity of his love for truth and declaring how intensely he hates a lie; at the same time gently intimating that his strength is so great that for him to err would be

impossible. Some, indeed, in these days do not hesitate to declare their own infallibility as regards scientific doctrines, while at the same time they display the most delicate —almost feminine—susceptibility if any one questions the correctness of their own conclusions, and manifest the most violent indignation if anyone dares to express an opinion differing from that which they have espoused. But science does not thus teach. Science profits largely by difference of opinion, and advocates the thorough examination of every step made in advance. Science does not permit her followers to espouse the doctrine of infallibility, and any one who displays arrogance, and boasts of his strength may be strong, indeed, and very powerful, but he cannot be scientific. These remarks, which apply to all science, are, as it appears to me, especially applicable to microscopical science, for it is impossible that our work can be too thoroughly, too minutely, or too frequently examined and re-examined. The sooner errors are exposed and correct observations confirmed the better for all. And this looking out for errors, and this confirmation of accurate statements is, as it appears to me, the very work that can be most advantageously carried out by the most advanced of our members. The work of each would in its turn be examined by others, and the exact truth would certainly be ascertained. If this were done microscopical observation would soon be very popular, and our science would occupy the position in public esteem which it ought long ago to have held, and it would be more generally taught than heretofore. But there are, I regret to say, many circumstances which tend to prejudice people against our enquiries, and which are not to be easily altered by any efforts we may make to do so. To some of these I propose to advert in the course of this address.

It would be difficult, indeed, I think, to find any subject so well adapted for training the mind, for the prosecution of

scientific work, as microscopical investigation. Few departments of work are so well calculated to make a man careful and thoughtful. The microscopical observer is constantly discovering and constantly correcting the discoveries he has already made. He cannot progress without continually learning new things, and correcting what he has already learnt. And if he is a thorough microscopist, he will be as careful not to publish too soon the results of his own observations, as he is not to lean too much upon the demonstrations of authorities until they have been confirmed by others. What prolonged training is required before a student can become an accurate observer! How slowly the microscopist progresses, and how patiently must he have worked before he is able to contribute observations which shall materially advance his department of science. The report of the work of the real observer only begins when the new facts upon which his conclusions are to be based have been positively demonstrated. In these days, however, many a man having scarcely any experience sits down to his work and very soon comes to the conclusion that he has discovered a fact that was not known before. He makes his drawings and publishes at once the results of his investigation. But the real observer proceeds in a very different manner. After having demonstrated a fact which he supposes to be new, he waits, consults authorities, and carefully thinks over what has been done before his time, and exactly what has been done by him. Then he proceeds to ascertain if the new conclusion is to be confirmed by investigations upon species of animal or plant different from the particular one examined by him. Only when he feels quite sure he is right does he begin to make drawings and arrange his facts for publication. This seems slow work for these days, but, as you will observe, of exactly the kind to correct the errors of the times in which we live.

How different is the value of slow, careful, and well cogitated work, compared with that of the rapidly produced, semi-conjectural assertion, which has been made to do duty for observation !

What subject, then, can be so well adapted for scientific training as microscopical enquiry properly pursued for a sufficient period of time? Now that we have good, cheap, and portable instruments, as well as all the accessory instruments and apparatus required, conveniently arranged, I wonder that our work has not become very popular among teachers and in general schools. It is well known how, by Microscopical work, everyone improves his powers of manipulation, increases the delicacy of his sense of touch, teaches himself patience, improves his sight, developes his powers of observation, and encourages exactness of thought and of description at the same time. And surely all these are of advantage and much to be desired in the training of youth. Moreover, it is equally well suited for both sexes; but, nevertheless, microscopical work can hardly be termed popular, and as yet is very little taught in any of our schools.

Unfortunately, like some other branches of knowledge, microscopic investigation has been neglected as of little educational value. It has been intentionally disparaged by the scientific brethren who call themselves strong, no doubt in order that their favourite pursuits might be made to appear more important, and stand a better chance of being admired and rendered popular. It is noteworthy that the departments of science that the public has heard most about of late years are those calculated rather to excite the astonishment of unlearned and somewhat idle people, than those which would excite the interest or appeal to the intellect of real students. Lest minute investigation should lead men to doubt whether all the wonderful phenomena

they observed, and the marvellous and beautiful structures they demonstrated, were really the consequence of physical changes only, they have been advised to study the general properties and forces of non-living matter, and not to pay much attention to points of minute detail. And the utmost energy has been displayed for the purpose of impressing upon pupils the dogma of physical causation. But in spite of all the manœuvres the greatest ingenuity could devise, in spite of the active help and cordial co-operation of some of the keenest intellects of our time, men do doubt if many things taught in the name of science, and most positively affirmed to be true, are true indeed. Some have even given expression to the doubts they entertain; and it is even to be feared that not a few intelligent persons having discovered that some scientific men had certainly wandered, in spite of their asseverations to the contrary, from the safe paths of observation and experiment, and had certainly lost themselves in the mazes of conjecture, have condemned scientific work generally as pretentious, boastful, arrogant, and untrustworthy. People who venerated pure intellect began to fancy that the days were fast approaching when the old ideas, which had so impressed the greatest minds in past centuries, would be set aside as myths, and spoken of as fables; when perhaps Christianity itself would have to give place to positive knowledge—but alas it is being found out that the *positive* is not knowledge, and that the knowledge we have is anything but positive. Had the pretentious assertions that have been made and believed during the last ten years been properly examined—had the facts so loudly proclaimed to be true, been subjected to careful analysis, one by one, and by persons properly trained to scientific investigation, how much higher might not science have risen in the estimation of the thoughtful? But any one who ventured to ask for time for consideration, or to recommend

caution, was condemned—efforts were directed to silence him, or prevent him from being heard, while the multitude were made to applaud as the chariot of science rushed by, whither no one cared, though all were enchanted by the rushing on.

The observations of some authorities almost lead us to infer that they believe that the only way to promote the successful investigation of nature is to inculcate a contempt for what has been already taught. The great aim of at least one school of philosophy would seem to be to emancipate mankind from the trammels of the past. But it is very easy to see that even before the old chains are snapped, our would-be liberators are hard at work forging for us fetters more galling than the old ones, and preparing for those who hesitate to accept their creed a new tyranny differing but little as regards its results from the tyrannies that have gone out of fashion. Nay, some philosophers are so imbued with the true proselytizing spirit, as to intimate that it would be an advantage to the world if a considerable number of persons who do not accept their views concerning this world and the next, were improved off the face of the earth, or somehow put down, in order that scientific liberty might be promoted without further opposition. Unbounded admiration for the discoveries of to-day, and contempt for much of what has been effected by those who have lived before us, is a curious characteristic of some of the most forward minds of these days. In speaking of events that have been recorded in history, Canon Kingsley himself, at one time a professor of History, tells us how "he resolved that he would not bother his head with things of that sort while he could get on without them." Farther on he points out that "the first thing we must learn to do is to be honest and say exactly what we have seen and heard and felt."* But surely it is very doubtful if the honesty of men would

* Address at Bristol, October, 1871.

increase if that virtue were to be acquired only by listening to those who told them exactly what they had seen and heard and felt. For my part I do not know anything more unpleasant than to have to listen to an exact description of what a person feels, but to be told all that a person—conscious of his unbounded honesty—feels about his own special virtue, would, it is to be feared, excite in many, and particularly in children, a determination to try to be anything but honest. But surely honesty is not one of the discoveries of the new Philosophy, a characteristic which has only just been evolved after a long course of natural selection? Potentially, of course, honesty existed in the lower forms of life, and who knows but that some correlate might have been discovered in those simple living things that came to our planet after a very long ride through space on the fragment of a more ancient world, if our means of investigation had been sufficiently exact?

It is not astonishing that our work has been found to be rather slow and unexciting in times like these, but in the quieter period that must succeed we may hope to engage a little interest, and be permitted to teach to others some of the facts familiar to ourselves, and even allowed to offer an opinion of the bearing of these facts upon grander and more momentous enquiries. No wonder that people who have been dazzled by the illuminated undulations of infinity, should scoff at the idea of discovering anything by looking at a growing speck. But now that the whole course of physical change upon our world has been fully determined and adequately accounted for, it is possible that people may care to be told something about the structure and mode of growth of themselves and the living things by which they are surrounded.

Men who love science for her own sake take delight in discussing the facts upon which their theories and hypotheses

are based, but for some years past certain conclusions have been unduly forced into notoriety by a few authorities who do not allow that they can be called in question. The man who dares to doubt, or ventures to ask for explanation, is either "tolerated," or called "weak" or "orthodox," or disposed of in one of many other ways known to the "strong brethren." A small but active band of strong brethren entertain in these days a *prava superstitio*, and flatter themselves that their tenets shall spread until at some time in the distant future they shall have no small influence upon the world about to be. If you express dissent from any doctrine they teach, your remarks will be completely passed over, or it will be publicly intimated that amongst a number of foolish objections perhaps the most absurd are those emanating from a person who has altogether misunderstood the question at issue, and to whom, therefore, it is not necessary to reply, &c., &c. If you urge that Mr. A also dissents, and that he has spent the last thirty years in investigating the matter, and is well known for the good work he has done, you will be answered by a condescending smile, and with a shrug of the shoulders—you will be asked who Mr. A may be, and in what way it signifies supposing he does not believe what in a material sense is infallibly true? This is exactly what we must expect. All workers and thinkers, except those who are contented to run along the only popular groove, must suffer rebuffs at the instance of the strong brethren. There is but one mode of escape, and that is to recant before it is too late, to give an assent to their favourite dogma, and speak publicly of their amazing strength. If you differ, you must suffer. Nor will it make the slightest difference whether you are student or teacher. Scientifically you may be on precisely the same level, but no matter, that knot of persons takes care that the public are repeatedly informed how very strong they are; and to give due force to their statements,

the strongest seems to be always brandishing a sledge-hammer, while some join in loud chorus every time the anvil is struck, and others add to the commotion that is made apparently for the purpose of leading people to think that very hard work must be going on where so much noise is produced.

That there is another side to many of the arguments now so forcibly advanced is well known; but it is for the public to determine whether they will hear the objections to popular doctrines, or whether they will not. If people decide that man is a physico-chemical mechanism, and that his physical basis is a molecular albuminoid protoplasmic colloid substance, it must be so. The people have a right to take any view they like upon any matter, artistic, political, philosophical, literary, or scientific. The few who desire to form a correct judgment are in the minority, and they may be permitted to obtain the facts they want as best they can. Their opinion is of no importance. There is, one would suppose, a good deal to be said against the doctrine that all causation is physical, but the dictum is carried by acclamation; so at least for a time it is held that physical causation is of universal application. It is quite certain that no one at this time can adequately explain by physics even the growth of a blade of grass, or the movements of the contents of the most minute cell, or the growth of any living thing whatever. But that is no matter. The cause must be physical because every cause is physical. People have determined to believe that everything is to be explained by physical law. There is no harm in believing this, only it is incorrect to conclude that the belief is in accordance with reason, and that it is grounded upon facts of observation and experiment. It is possible that some one may be about to obtain new data for the belief, but in the meantime the faithful should abstain from speaking con-

temptuously of those who differ from them in opinion. And it is not in accordance with philosophic principles to refuse to accept or to ridicule the evidence brought by the microscopical observer on the plea that he is a mere microscopist—an injector—a putter up of preparations, and so forth. His evidence after all may be very important, and must at least be of more value than the conjectural hypothesis of the physical imagination.

Hard and unsparing has been the criticism of the weak brethren by those who call themselves very strong. No one would believe that the weak and the strong were working together in the same great workshop for the same great end. Some in our department, notwithstanding the fact that they have served their apprenticeship with credit, and have never scamped the work they were set to do, have been condemned almost by name. Our instrument of research has been called "mischievous," and that most unpleasant qualification, "mere," has been inserted before the epithet which is applied to us by our fellow-workmen who have embraced the new philosophy. Now, let us indulge in a little friendly criticism for the benefit of our strong friends. The microscopical observer, although wanting in the remarkable intensity and self-confidence by which the physicist is distinguished, may nevertheless succeed in showing certain details of structure and peculiarities of constitution which elude other methods of physical research, but which are worthy of the attention of every one working in nature's workshop. At the same time it is very desirable that microscopists should have a clear understanding concerning what is comprised under the term Physics—a department of science which is to be taught in elementary schools, and which girls as well as boys are expected to learn. We will examine the term physics with a very moderate power, and endeavour to ascertain what the girls and boys of the rising generation

are to be taught under this head. And in order that we may examine with good chance of success, we will appeal to a physicist, and consider the definition which has been given by him in an elementary text-book recently published. The little work in question is one of a series of primers sanctioned by an authority well known for expressing exactly what he thinks,—an authority who has condemned scientific text-books generally, and who has of course taken care that the series which he edits shall be wanting in the many short-comings for which children's books are so sadly celebrated. These new text-books probably approach perfection more nearly than any preceding work.

I will now give you an example of the sort of knowledge that is to be forced into the heads of the rising generation. The little boys and girls attending the schools of the future are to be enlightened concerning the meaning of physics in this wise:—"You have been told about the *kinds* of things we have in the world, but you have not yet learned much about the *moods* or *affections* of things." The child may feel a little puzzled about the *affections* and *moods* of *things* around him, and will ask himself perhaps what can be meant by the affections, say of the tables, chairs, fire-irons, and the moods of the pots and pans, but his physical teacher soon makes all clear to his physical comprehension, "you are, yourself, little child," says the teacher, "subject to change of moods; sometimes you appear with a smile on your face, and sometimes perhaps with a face full of frowns or tears; sometimes, again, you feel vigorous and active; sometimes dull and listless." The child has been already taught about oxygen and hydrogen, and water and iron, and has been shown that some things are compound, and can be split up into other things, and that some things are simple and cannot be so split up; but now the teacher begins to explain all about the moods and affections of *things*, and commences his ex-

position by the *argumentum ad puerum.* "You are a thing, and you have your moods—sometimes a smile is on your face, but sometimes your face is quite full of frowns and tears." The apt little scholar soon satisfies himself that he is a thing, and finds out that things like himself have affections and moods. When he looks about after his lesson is over, he sees the poker smiling at the tongs, while the face of the shovel is full of tears, and looks offended and angry. The tabula rasa of the child, that has been carefully protected from the contaminating influence of Jack the Giant killer, and remains uninjured by ridiculous fairy tales, soon has impressed upon it the truths of exact physical science. The little pupil is able to demonstrate most conclusively to himself and his little friends when the chairs and tables are feeling vigorous and active, and when the dog and the dining table and the canary bird are perfectly dull and listless! But let us be serious, and proceed to the next step in the lesson on the definition of Physics. The physicist says, "Now, if you think a little you will *see* that the things around you are subject to moods very like yours." The little pupil is to *think* in order that he may *see* that the objects around him have moods like his own. They smile and frown, and feel vigorous or listless just as he does! But he and the things around are not the only possessors of faces. Nature has a face. "To-day the face of nature *looks* bright and happy, and full of smiles; to-morrow the same face is dark and lowering," and so on.

But I have not yet got far in the definition of Physics, and it is but fair that I should bring under your notice the last paragraph of the definition, in which the subject of causation is referred to. "Now, if we see you crying and unhappy, we ask, what is the cause of this mood, and we always find there is a cause (physical?); or if we find you listless and sleepy, and wanting in energy, we enquire what is the meaning of all this, and we find that it has a meaning

and a cause (physical incapacity?). So, likewise, when we find changes in the moods or qualities of dead matter, we inquire what is the cause of these changes, and we always find they have a cause." It would not, I think, be very difficult to find what would be the *consequence* of such teaching as this. For my part, I think it would be advantageous to let the child prepare himself for physical studies of this kind by learning such highly suggestive lines as the following, from one of the most philosophical works that has issued from the press for a long while:—

> "Far and few, far and few,
> "Are the lands where the Jumblies live;
> "Their heads are green and their hands are blue,
> "And they went to sea in a sieve, they did,
> "In a sieve they went to sea."

Now, I should be very sorry if anything that I have said should lead you to suppose that I desire to depreciate physics or any department of natural knowledge. For every branch of human information I entertain the highest respect, and I doubt if anyone feels more strongly than I do the desirability of teaching science, and particularly certain departments of physics; but there is room for the greatest difference of opinion concerning what should be taught, and how the teaching should be conducted. And pray do not suppose that, because I have studied one subject, I am trying to raise it in importance at the expense of another. I desire to see all departments of science fairly taught and fairly treated. No one person can follow more than one branch of investigation. Of many subjects most of us must remain in total ignorance; and of those who love and live but to prosecute one particular investigation, the great majority must submit to be ignorant of many things well worth knowing, and that they ought to know—but this will ever be. The man who is most active and most successful in one line of work will

have to neglect other pursuits that he may concentrate his whole thought upon what he has to do. But he need not undervalue or disparage the work of others, who find in subjects foreign to his own, life-long occupation and interest. One of the most painful things to witness in our day is the contempt displayed by some who have risen to fame in a special department, when they refer to the works and thoughts of other men not less distinguished, though in a line different from that which they have selected. A liberal minister calls people who differ from him in opinion, "ignorant and incapable." Another seems quite unable to find words which should convey an adequate conception of what he himself feels concerning the labours of artists, sculptors, botanists, and people who know something about organic matter and inorganic matter. A physicist raises a tremendous dust, which smothers and obscures a good many things for a time, but does no good nor harm to anything in the end. A chemist teaches us many odd things concerning life, though he has no idea of the changes which occur in matter that is alive. It is quite curious how eminence in one subject is admitted as a qualification for a man to express himself strongly concerning something very different, and to determine questions of a totally distinct order from any which he has been engaged in investigating. An intimate knowledge of certain material forces enables a man to estimate to a fraction the exact amount of religious truth that there is and has been in the world, and qualifies him for determining conclusively and to a nicety the precise value of prayer. Success in the study of extinct animals places the student in a judicial position of such eminence, that he is permitted not only to deliver an authoritative judgment concerning matters which have troubled many of the greatest intellects for centuries, but to pass sentence upon those who differ from him. To some dispositions it must be very pleasant to wield such vast

power ; but it is not easy to see how the spread of natural knowledge is promoted thereby, or what advantage accrues to science. Nor does the power of setting down other people rest upon very scientific principles. The idea seems rather to be taken from a leaf torn out of the book of the philosophy of tyrants and despots, who endeavour to enslave everyone but themselves, and trample upon the charter of scientific liberty.

From our side there is indeed much to be said upon the great questions that agitate men's minds at this time ; but we are mere microscopists ; and although we may know something about the formation, and structure, and action of the parts of which man is composed, it would be absurd to suppose that we could form any opinion concerning man himself. That must be left to those who study inorganic matter and its forces. We are, I fear, condemned as unfitted to survive in the struggle for existence, and must be contented to form the material for sustaining our stronger brethren, who, without us, would be in danger of perishing from starvation.

And now, gentlemen, I must thank you for the patience you have shown towards me. I wish it had been possible for me to have properly discharged the duties of the position in which you placed me two years ago ; but my friend, Dr. Braithwaite, whom you have elected as my successor, and to whom I am indebted for occupying on several occasions the chair I was obliged to desert, will more than make amends for the short-comings of your late President.

TREASURER'S REPORT.

JUNE 30TH, 1872.

RECEIPTS.	£	s.	d.	PAYMENTS.	£	s.	d.
By Balance	36	13	1	Printing and Stationery	51	14	6
Subscriptions	225	6	6	Postage	10	11	7
Interest on Deposit	0	5	6	Attendance	11	15	0
Composition	10	0	0	Purchase of Property	7	13	0
				Advertisements	0	14	0
				Journal	95	0	0
				Soirée	59	16	4
				Petty Expenses	12	13	6
				Composition to Invest	10	0	0
				Balance at Bank	12	7	2
	£272	5	1		£272	5	1

We, the undersigned, having examined the above statement of Income and Expenditure, and the Vouchers referring thereto, hereby certify that the said Account is correct.

W. T. SUFFOLK,
H. H. DOBSON, } *Auditors.*

HONORARY FOREIGN MEMBERS.

Date of Election.	
Oct. 25, 1867	Guiseppe de Notaris, *Professor of Botany, &c., &c.*, Genoa.
Jan. 24, 1868	Arthur Meade Edwards, M.D., 314 West Thirty-fourth-street, New York.
Mar. 19, 1869	Rev. E. C. Bolles (*Ex-President of the Portland Society of Natural History*), Brooklyn, New York.
July 26, 1872	S. O. Lindberg, M.D., Professor of Botany, University of Helsingfors, Finland.
July 26, 1872	Prof. Hamilton L. Smith, President of Hobart-College, Geneva, New York, U.S.A.
July 26, 1872	Dr. J .Woodward, Assist. Surgeon General, U.S.A., Washington.

LIST OF MEMBERS.

Date of Election.	
Sept. 24, 1869	Ackland, William, 122 Newgate-street, E.C.
April 22, 1870	Adams, William, F.R.C.S., 37 Harrington-square, N.W.
Nov. 27, 1868	Adkins, William, 270 Oxford-street, W.
Oct. 27, 1865	Aldous, W. Lens, 47 Liverpool-street, W.C.
Mar. 23, 1866	Allbon, W., F.R.M.S., 525 New Oxford-street, W.C.
Oct. 28, 1870	Allen, Rev. Francis H., Warwick Villa, New Hampton, Surrey.
Sept. 27, 1867	Allen, John T., 57 Cross-street, Islington, N.
July 23, 1869	Allen, W. H., C.E., 2 Abingdon-villas, Kensington, W.
July 26, 1872	Alstone, John, 4, Myddelton-square, E.C.
Dec. 17, 1869	Ames, George Acland, Union Club, Trafalgar-square, S.W.
Sept. 25, 1868	Andrew, Arthur R., 3 Neville-terrace, Fulham-road, S.W.
Dec. 22, 1865	Andrew, F.W., 3 Neville-terrace, Fulham-rd., S.W.
Sept. 22, 1865	Annett, James, Hampton, S.W.
July 7, 1856	Archer, J. A., 172 Strand, W.C.
Dec. 18, 1868	Ashby, John, Staines.
Feb. 23, 1872	Atkins, A., M.R.C.S., 232 Mile End-road, E.
Feb. 23, 1872	Atkins, A., jun., L.R.C.P., 236 Mile End-road, E.
Dec. 22, 1865	Atkinson, John, 54 Brook-street, W.
Feb. 26, 1869	Atkinson, William, F.L.S., 47 Gordon-square, W.C.
Mar. 27, 1868	Aubert, Alfred, Lloyds, E.C.
Nov. 25, 1870	Baber, Edward Cresswell, M.D., 34 Thurloe-square, S.W.
May 22, 1868	Bailey, Capt. L. C., R.N., F.R.G.S., R.A.S., Topographical Dept., New-st., Spring-gardens, S.W.

Date of Election.	
July 26, 1867	Bailey, George H., M.R.C.S., 25 Charles-street, Middlesex Hospital, W.
Dec. 27, 1867	Bailey, John W., 75 Broke-road, Dalston, E.
April 24, 1868	Baker, Charles, F.R.M.S., 244 High Holborn, W.C.
May 26, 1871	Balshaw, Rev. Robert, 55 Bessborough Gardens, S.W.
Mar. 24, 1871	Baly, Charles, 75 Margaret-street, W.
Aug. 23, 1867	Bannister, Richard, F.R.M.S., The Laboratory, Somerset-house, W.C.
Nov. 23, 1866	Barnes, Capt. E., York.
Nov. 25, 1870	Barnes, Herbert J., 2 Richmond-villas, Union-rd., Highbury, N.
April 22, 1870	Barnes, Charles Barritt, 66 Old Broad-street, E.C.
June 23, 1871	Bartlett, Wm. P., 2A Eastbourne-terrace, W.
Oct. 27, 1865	Barratt, T. J., 91 Great Russell-street, W.C.
June 24, 1870	BEALE, LIONEL S., M.B., F.R.S. (*Vice-President*), 61 Grosvenor-street, W.
June 25, 1869	Beale, Charles J., Box 110, Post Office, Toronto, Canada.
Dec. 27, 1867	Bealey, Adam, M.D., Oak Lea, Harrogate.
May 28, 1869	Bean, Charles E., Brooklyn-house, Goldhawk-road, Shepherd's Bush, W.
Oct. 26, 1866	Beck, Joseph, F.R.M.S., 31 Cornhill, E.C.
May 26, 1871	Bedwell, Fras. Alfred, M.A., Cantab., 3 Old Square, Lincoln's Inn, W.C.
Aug. 23, 1867	Bell, James, F.R.M.S., The Laboratory, Somerset-house, W.C.
May 24, 1872	Bennett, W. H., St. George's Hospital, S.W.
Mar. 24, 1871	Bentley, Algernon Royds, 9 Portland-place, W.
Dec. 27, 1867	Bentley, C. S., Hazellville Villa, Sunnyside-road, Hornsey-rise, N.
May 22, 1868	Berney, John, F.R.M.S., 61 North-end, Croydon.
Oct. 23, 1868	Bevington, W. A., F.R.M.S., 113 Grange-road, S.E.
Mar. 27, 1868	Bidlake, J. P., B.A., F.C.P., F.C.S., F.R.M.S., 318, Essex-road, N.
June 24, 1870	Birch, A. E., 47 Halliford-street, Islington, N.
Jan. 25, 1867	Bird, Peter Hinckes, M.D., 1 Norfolk-square, Hyde-park, W.
July 28, 1871	Bishop, Wm., 23A, Hungerford-road, N.

Date of Election.	
Nov. 22, 1867	Blake, F. W., 5 Serle-street, Lincoln's-inn, W.C.
Feb. 23, 1866	Blake, T., 6 Charlotte-terrace, Brook-green, Hammersmith, W.
Mar. 19, 1869	Blankley, Frederick, F.R.M.S., 23 Belitha-villas, Barnsbury, N.
Mar. 19, 1869	Blight, Rev. R., The Vicarage, Bredwardine, Hereford.
June 25, 1869	Bond, George, 11 St. Thomas'-place, Hackney, N.E.
April 22, 1870	Bossy, Alfred Horsley, Prospect Cottages, Stoke Newington, N.
Nov. 27, 1868	Boustead, James, Stourfield Lodge, Effra-road, Brixton, S.E.
Mar. 27, 1868	Bowing, John, 6 Bowater-crescent, Woolwich, S.E.
July 23, 1869	Boyer, Richard, 20 Park-terrace, Highbury, N.
Oct. 23, 1868	Brabham, T., 61 Castle-st., Leicester-square, W.C.
Dec. 22, 1865	Brain, T., 1 Upper Vernon-street, Lloyd-sq., W.C.
Oct. 27, 1865	BRAITHWAITE, R., M.D., M.R.C.S.E., F.L.S., F.R.M.S. (*President*), The Ferns, Clapham-rise, S.W.
June 26, 1868	Briggs, H. B., 36½ Upper Thames-street, E.C.
May 27, 1870	Brigham, H. G., St. George's Hospital, S.W.
Mar. 22, 1867	Brightween, G., 8 Finch-lane, E.C.
Jan. 22, 1869	Brookes, William, 380 Camden-road, Holloway, N.
May 27, 1870	Brown, George Dransfield, M.R.C.S., Uxbridge-road, Ealing, W.
Dec. 28, 1866	Brown, W., 203 Great Portland-street, W.
May 22, 1868	Brown, W. J., 37 Penshurst-road, South Hackney, E.
May 26, 1871	Browne, George, 80 Pratt-street, Camden-town, N.W.
Feb. 27. 1872	Browne, Rev. Thomas Henry, F.R.M.S., High Wycombe, Bucks.
May 24, 1867	Browne, H., 40 Camden-square, N.W.
May 25, 1866	Buchanan, A., 382 Camden-road, N.
June 23, 1871	Bucknall, Cedric, 1 Stamford-hill-grove, East Upper Clapton, E.
Jan. 28, 1870	Bull, William J., M.A., Harrow.
May 24, 1872	Burch, Geo. J., Flint Cottages, Cheshunt, Herts.
Sept. 28, 1866	Burgess, J. W., 329 Hackney-road, N.E.

Date of Election.	
Feb. 23, 1866	Burgess, N., 329 Hackney-road, N.E.
June 25, 1869	Burgess, W. F., Guy's Hospital, S.E.
Aug. 26, 1870	Burgess, Martin, 3 Mount Pleasant-terrace, Upper Lewisham-road, S.E.
April 24, 1868	Burr, T. W., F.R.A.S., F.C.S., F.R.M.S., 15 Tiberton-square, N.
Oct. 23, 1868	Burrows, C. R. N., Wanstead, Essex, N.E.
April 24, 1868	Burrows, John, Wanstead, N.E.
Mar. 27, 1868	Burrows, J. Nelson, The Grove, Wanstead, N.E.
June 14, 1865	Bywater, Witham M., F.R.M.S., 5 Hanover-square, W.
July 27, 1866	Bywater, W. M., jun., 5 Hanover-square, W.
May 24, 1867	Callaghan, James, 12 Coal-yard, W.C.
Sept. 25, 1868	Capel, Charles C., Little Blake Hall, Wanstead, Essex.
May 26, 1871	Catchpole, Robert, 101 Lancaster-road, Notting-hill, W.
Dec. 27, 1867	Chapman, W. C., 39 Granville-square, W.C.
Nov. 26, 1869	Chater, E. M., Watford, Herts.
Sept. 23, 1870	Cheverton, George, High-street, Tunbridge Wells.
July 28, 1871	Clark, Fred. Cheesman, Farnham-house, Morland-road, Croydon.
May 26, 1871	Coales, Dr. R., 119 Gower-street, W.C.
May 22, 1868	Cocks, W. G., 18 Kent-villas, Grange-road-east, Dalston, N.E.
May 28, 1869	Cole, Walter B., St. John's-terrace, Weymouth.
Jan. 25, 1867	Coles, Ferdinand, A.P.S., 248 King's-road, Chelsea, S.W.
Feb. 23, 1872	Colvin, Alexander, Barham Lodge, Weybridge, Surrey.
April 23, 1869	Collings, Thomas P., 38 Surrey-street, Strand, W.C.
July 7, 1865	Collins, C., F.R.M.S., 159 Great Portland-st., W.
May 22, 1868	Collins, James, Pharmaceutical Society, Bloomsbury-square, W.C.
Sept. 23, 1870	Connor, Rochfort, 9 St. Martin's-road, Stockwell, S.W.

Date of Election.	
Mar. 19, 1869	Cooke, Geo. E., 20 Osnaburgh-street, Regent's-park, N.W.
June 14, 1865	Cooke, M. C. (*Sect. for Foreign Correspondence*), 2 Grosvenor-villas, Junction-rd., Upper Holloway, N.
Feb. 22, 1867	Cooper, Frank W., L.R.C.S. Edin., Leytonstone, N.E.
Mar. 23, 1869	Coppock, C., F.M.S., F.M.R.S., 31 Cornhill, E.C.
Dec. 17, 1869	Coppock, Jones Henry, Bridport, Dorset.
May 28, 1869	Cottam, Arthur, F.R.A.S., Office of Woods, Whitehall, S.W.
Aug. 28, 1868	Cousens, John, Grove-road, Wanstead, N.E.
July 26, 1872	Cowan, Thos. Wm., Hawthorn-house, Horsham, Sussex.
July 23, 1869	Creer, Edwin A. O., 2 Albany-place, Commercial-road East, E.
Aug. 28, 1868	Crisp, Frank, 134 Adelaide-road, N.W.
Dec. 23, 1870	Crisp, John S., 62 Camberwell-road, S.E.
Feb. 27, 1868	Crook, Thomas, F.R.M.S., Eden-street, Kingston, Surrey.
Oct. 26, 1866	Crookes, Wm., F.R.S., 20 Mornington-road, N.W.
July 7, 1865	Crosbie, J. J., The Chesnuts, Lyonsdown-road, New Barnet.
July 26, 1867	Cross, R., M.D., 4 Craven-street, Strand, W.C.
Sept. 28, 1866	Crouch, Henry, F.R.M.S., 51 London-wall, E.C.
Mar. 27, 1868	Cubitt, Charles, F.R.M.S., 6 Great George-street, Westminster, S.W
May 25, 1866	Curties, T., F.R.M.S., 244 High Holborn, W.C.
April 26, 1872	Curwen, Herbert, Workington-house, Upton, Essex.
June 25, 1868	Darnley, D. Rowland, 12 John-street, Bedford-row, W.C.
June 23, 1871	D'Aubney, Thos., Shepherdess-walk, Hoxton, N.
Mar. 22, 1872	Daintrey, George, 43 Oakley-road, Southgate-road, N.
April 27, 1866	Davis, S., 11 Priory-road, South Lambeth, S.W.
Oct. 22, 1869	Davis, Henry, 19 Warwick-street, Leamington.
Dec. 23, 1870	Dawson, George M., Royal School of Mines, S.W.

Date of Election.	
May 25, 1866	Dawson, J. E., F.R.M.S., Oak Lodge, Park-road, Watford.
May 22, 1868	Dean, G. A. H., Elmwood, Catford-bridge, Kent, S.E.
Jan. 22, 1869	Deed, Alfred, 94 King Henry's-road, Primrose-hill, N.W.
Nov. 27, 1868	Delferier, William, F.R.M.S., 40 Sloane-square, S.W.
April 23, 1869	Delferier, Arthur, 40, Sloane-square, S.W.
Feb. 27, 1868	Dempsey, Joseph M., M.D., F.R.M.S., 27 Charterhouse-square, E.C.
Jan. 26, 1872	Denyer, Edwin, High-street, Windsor.
July 23, 1869	Devenish, Samuel, 2 Champion-grove, Denmark-hill, S.E.
June 26, 1868	Dickens, Charles, Latimer-house, Hadley, Middlesex.
Feb. 25, 1870	Diss, William Jas., 17 Spurstowe-road, Amherst-road, Hackney, N.E.
Dec. 22, 1865	Dix, James, 26 Pentonville-road, N.
Nov. 24, 1865	Dobson, H. H., F.R.M.S., Pelham Lodge, Alexandra-road, St. John's-wood, N.W.
Jan. 25, 1867	Dodd, Josiah E., 11 Margaret-street, Cavendish-square, W.
July 26, 1872	Doggett, Ernest, 3 Liquorpond-street, W.C.
Sept. 23, 1870	Dolamore, William, 30 Regent-street, S.W.
Aug. 28, 1868	Donaldson, Alexander L., 14 Wigmore-street, W.
Nov. 27, 1868	Douglas, Rev. R. C., Manaton Rectory, Moreton-hampstead, Exeter.
Jan. 28, 1870	Dowson, Edward, M.D., F.R.M.S., 117 Park-st., Grosvenor-square, W.
Dec. 27, 1867	Draper, E. T., F.R.M.S., Harringay-park, Hornsey, N.
July 28, 1871	Drew, G. C., Milton-house, Cassland-road, South Hackney.
Dec. 23, 1870	Duck, William A., 43 St. George's-road, Southwark, S.E.
April 26, 1872	Dudgeon, R. E., M.D., 53 Montagu-square, W.
Sept. 22, 1865	DURHAM, ARTHUR E., F.L.S., F.R.M.S., 82 Brook-street, Grosvenor-square, W.

Date of Election.	
Nov. 23, 1866	Durham, F., M.B., F.R.C.S., 14 St. Thomas's-street, S.E.
Aug. 26, 1868	Duer, Y., Cleygate, near Esher, Surrey.
Sept. 25, 1868	Eddy, James Ray, F.R.M.S., F.G.S., Carleton-grange, Skipton, Yorkshire.
July 27, 1865	Emery, J. J., 99 St. George's-road, Southwark, S.E.
May 26, 1871	Enock, Frederick, 48 Tollington-road, Holloway, N.
Sept. 24, 1869	Epps, Richard, M.R.C.S., 89 Great Russell-street, Bloomsbury.
Dec. 18, 1868	Eyre, Samuel, Belmore-lodge, Priory-grove, South Lambeth, S.W.
May 28, 1869	Farmer, Richard, F.R.M.S., F.G.S., Hornsey, N.
Nov. 23, 1866	Fawn, George, 19 Alexandra-road, St. John's-wood, N.W.
Mar. 27, 1868	Field, James, High-street, Highgate, N.
July 26, 1867	Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh-house, Highbury New-park, N.
May 22, 1868	Ford, W. B., Claremont-cottage, Colney-hatch-road, Wood-green.
Jan. 27, 1871	Forshaw, Thos., Jun., the Bower, Bowden, Altrincham, Cheshire.
Aug. 4, 1865	FOSTER, PETER LE NEVE, M.A., Cantab, F.R.M.S., Society of Arts, Adelphi, W.C.
April 22, 1870	Foster, John, 213 Regent-street, W.
Mar. 24, 1871	Foulerton, Dr. J., Thatched-house Club, Saint James's-street, S.W.
Oct. 22, 1869	Fox, Charles James, M.R.C.S., 27 Mortimer-street, W.
Dec. 28, 1866	Fox, C. J., F.R.M.S., 16 Cork-street, Bond-street, W.
July 26, 1872	Francis, T. Harper, 335 Gray's Inn-road, W.C.
June 23, 1871	Freeman, Henry E., 10 Durnford-road-east, Holloway, N.

Date of Election.

May 26, 1871	Freshwater, Thos. E., 2 Charlotte-street, Caledonian-road, N.
Feb. 26, 1869	Fricker, C. J., 4 Weston-hill-terrace, Upper Norwood, S.E.
May 22, 1868	Fryer, G. Henry, F.R.M.S., 13 West Abbey-road, St. John's-wood, N.W.
Oct. 26, 1868	Furlonge, W. H., Coed Mawr-house, Holywell, Flintshire.
July 28, 1871	Furneaux, John Richard, Boxgrove-house, Mayow-park, Forest-hill, S.
Nov. 25, 1870	Fyfe, Andrew, M.D., 42 Montpelier-square, S.W.

Mar. 19, 1869	Gann, James, W., 171 Fenchurch-street, E.C.
Mar. 25, 1870	Garden, Robert Spring, 42 Carlton-hill, St. John's-wood, N.W.
May 25, 1866	Gardiner, G., 244 High Holborn, W.C.
April 24, 1868	Garnham, John, F.R.M S., 123 Bunhill-row, E.C.
July 7, 1865	Gay, F. W., F.R.M.S., 113 High Holborn, W.C.
Sept. 22, 1865	Geddes, P., Millbank, Westminster, S.W.
Jan. 28, 1870	Gellatly, Peter, Loughton, Essex.
July 26, 1867	George, Edward, F.R.M.S., 12 Derby-villas, Forest-hill, S.E.
Mar. 22, 1867	George, Henry, 65 Castle-street, Oxford-market, W.
July 22, 1870	Gibson, Joseph F., 3 Furnival's-inn, E.C.
June 14, 1865	Gibson, W., 273 Regent-street, W.
Aug. 23, 1867	Gilbert, C. H. D., 65 Ludgate-hill, E.C.
Oct. 27, 1871	Goddard, D. E., 2 Ellesmere-villas, Devonshire-road, Forest-hill, S.E.
Nov. 22, 1867	Golding, W. H., 19 Regina-road, Tollington-park, N.
Dec. 23, 1870	Goldsmith, John Charles, 5 America-square, E.C.
Nov. 25, 1870	Goldsmith, S. J., St. George's-hospital, S.W.
Oct. 26, 1866	Gooch, James W., 23 High-street, Eton.
Dec. 22, 1864	Goode, W., 8 Bath-terrace, Lavender-hill, Wandsworth-road.
April 26, 1872	Goodinge, James Wallinger, 18 Aldersgate-street, E.C.
Mar. 27, 1866	Gray, S. Octavus, 44 Doughty-street, W.C.

Date of Election.	
Dec. 22, 1865	Gray, W. J., M.D., F.R.M.S., 41 Queen Anne-street, Cavendish-square, W.
Feb. 25, 1870	Gray, Henry J., 27 Highgate-road, N.W.
Jan. 28, 1870	Green, Nathaniel E., 3 Circus-road, St. John's-wood, N.W.
Oct. 28, 1870	Greene, Wm. Asbury, Parkshot, Richmond, Surrey
Oct. 23, 1868	Greenish, T., F.R.M.S., 20 New-street, Dorset-square, S.W.
Oct. 23, 1868	Gregory, Henry R., 10 Edith-grove, Fulham-road, S.W.
May 25, 1866	Griffiths, A. W., 2 St. Mark's-road, Windsor.
July 24, 1868	Groves, J. W., 25 Charlotte-street, Bedford-sq. W.C.
July 24, 1868	Grubbe, E. W., C.E., 49 Queen's-gardens, Hyde-park, W.
Jan. 27, 1871	Guimaraens, Augustus de Souza, 120 Ossulton st., Euston-square, N.W.
Mar. 22, 1872	Guyton, Joseph, 6 Apsley-terrace, Acton, W.
June 14, 1865	Hailes, Henry F., 7 Harringay-road, Hornsey, N.
Aug. 26, 1870	Hailstone, Robert H., 35 Walworth-road, S.E.
Aug. 23, 1867	Hainworth, John, 138 Camden-road, N.W.
Feb. 23, 1867	Hainworth, W., Jun., Clare-villa, Cricketfield-rd., Lower Clapton.
Mar. 19, 1869	Hall, Marshall, Captn., F.G.S., F.C.S., New University Club, St. James's-street, S.W.
Dec. 28, 1866	Hallett, R. J., Hampton-house, Kilburn, N.W.
Oct. 26, 1866	Halley, Alexander, M.D., 7 Harley-street, W.
Feb. 22, 1869	Hammond, A., 3 Alexandra-road, Marine-town, Sheerness.
Oct. 22, 1869	Harcourt, Cyril B., St. George's Hospital, S.W.
June 14, 1865	Hardwicke, Robert, F.L.S. (*Treasurer*), 192 Piccadilly, W.
Sept. 28, 1866	Harkness, W., F.R.M.S., Laboratory, Somerset-house, W.C.
June 23, 1871	Harris, Edward, 54 Hatton-garden, E.C.
May 22, 1868	Harris, W. H., F.C.S., Bombay.
July 26, 1872	Harrod, John, 3 Great Tower-street, E.C.
Aug. 24, 1866	HART, ERNEST, 42 Harley-street, W.

Date of Election.	
Oct. 26, 1866	Hart, G. W., Letterfrack, Co. Galway, Ireland.
Nov. 26, 1869	Hart, Edward, Highbury New-park.
Nov. 24, 1871	Hawker, Charles, M.D., 2 Albion-terrace, White Horse-lane, Stepney, E.
June 28, 1867	Hawksley, Thos. P., 4 Blenheim-street, New Bond-street, W.
June 24, 1870	Hawkins, Samuel J., Bleak Dean, near Heptonstall, Manchester.
May 27, 1870	Haywood, Henry, Dartmouth-terrace, Rotherhithe, S.E.
Aug. 28, 1868	Heawood, Francis R. H., 80 Mark-lane, E.C.
Jan. 25, 1867	Heisch, Charles, F.R.M.S., South-villa, Hampstead-heath, N.W.
Aug. 23, 1867	Helm, Henry, J., F.R.M.S., The Laboratory, Somerset-house, W.C.
Aug. 26, 1870	Hennell, Col. S., F.R.M.S., Ventnor-villa, Ventnor, Isle of Wight.
June 26, 1868	Henry, A. H., 49 Queen's-garden, Hyde-park, W.
May 22, 1868	Hicks, J. J., 8 Hatton-garden, E.C.
Nov. 24, 1868	Hide, T. C., 46 Fenchurch-street, E.C.
June 14, 1865	Highley, S., F.G.S., 10A Great Portland-street, W.
Sept. 24, 1869	Hilton, J. D., M.D., Upper Deal, Deal, Kent.
Dec. 17, 1869	Hill, D. W., 78 Highbury New-park, N.
May 22, 1868	Hill, W. T., 4 Trinidad-place, Liverpool-road, N.
Sept. 28, 1866	Hind, F. H. P., Bartholomew-house, Bartholomew-lane, E.C.
May 26, 1871	Hinton, Chas. Howard, 18 Savile-row, W.
May 24, 1872	Hinton, Ernest, 42 Grafton-street, Seven Sisters-road, Holloway, N.
Aug. 26, 1870	Hirst, John, Jun., F.R.M.S., Dobcross, near Manchester.
Aug. 4, 1865	Hislop, W., F.R.A.S., 177 St. John-street-road, Clerkenwell, E.C.
Dec. 23, 1870	Histed, Edward, 27 Haymarket, S.W.
Oct. 26, 1866	Holdernesse, W. B., 12 Park-street, Windsor.
May 22, 1868	Holdsworth, Joseph, 33 Upper-street, Islington, N.
July 24, 1868	Holmes, W., M.R.C.S., 1 Brighton-villas, Lower Norwood, S.E.
April 27, 1866	Holtzapffel, J., A.I.C.E., 5 Great Coram-st., W.C.

Date of Election.	
April 26, 1867	Hooton, C., 3 Horningston-villas, Junction-rd., N.
May 22, 1868	Hopkinson, J., F.R.M.S., 8 Lawn-road, Haverstock-hill, N.W.
July 23, 1869	Horn, William E., 50 Bessborough-street, S.W.
May 27, 1870	Horn, T. W., 6 Clarence-road, Finsbury-park, N.
Oct. 26, 1866	Horncastle, H., Edwinstowe, near Ollerton, Notts.
June 25, 1869	Houghton, W., Walthamstow, Essex.
April 26, 1867	Hovendon, F., 93 City-road, E.C.
Mar. 27, 1868	How, James, F.R.M.S., 2 Foster-lane, E.C.
Jan. 26, 1872	Hudson, Robert, F.R.S., Clapham-common, S.W.
Feb. 25, 1870	Hudleston, W. H., F.G.S., J.P.. 23 Cheyne-walk, S.W.
Oct. 23, 1868	Hughes, R. H., B.A. Jesus Coll., Camb., 6 The Terrace, Putney, S.W.
June 25, 1869	Humphreys, Henry, B.A., 9 Amhurst-road-west, N.E.
Dec. 28, 1866	Hunt, W. H. B., F.R.M.S., 23 Eversholt-street, Oakley-square, N.W.
Nov. 24, 1871	Hurdell, Charles, 9 North Audley-street, W.
May 24, 1867	Hutchinson, F., M.D., 29 Woburn-place, Russell-square, W.C.
Nov. 25, 1870	Hutton, Rev. Wyndham M., Lezayre-vicarage, Ramsey, Isle of Man.
May 24, 1867	Ingpen, John E., F.R.M.S., 7 Putney-hill, S.W.
June 23, 1871	Isaac, Thomas, Maldon, Essex.
Feb. 23, 1872	Izod, Theodore, Chas., 10 Grange-villas, Grange-road, Upper Clapton.
Dec. 17, 1869	Jackson, B. D., 2 Morland-villas, Gresham-road, Brixton, S.W.
July 24, 1868	Jackson, F. R., Culver-cottage, Flindon, Arundel, Sussex.
June 14, 1865	Jaques, Edward, F.R.M.S., Woods and Forests Office, Whitehall, S.W.
June 26, 1868	Jeakes, Lt.-Colonel, Winchester-hall, Highgate, N.
Jan. 27, 1871	Jefferson, Henry, Eldon-house, Clapham-common.

Date of Election.	
April 23, 1869	Jefferson, Thomas, 17 The Pavement, Clapham-common, S.W.
July 24, 1868	Jennings, Rev. Nathaniel, M.A., F.R.A.S., 66 Avenue-road, Regent's-park, N.W.
Jan. 24, 1868	Jewell, C. C., 2 Great Queen-street, W.C.
July 22, 1870	Johnson, F., Barnsbury-house School, Islington, N.
Jan. 25, 1867	Johnson, John A., 15 Wellington-road, Stoke Newington, N.
Oct. 28, 1870	Johnson, Arthur J., Weston, Toronto, Canada.
Feb. 24, 1871	Johnson, M. Hawkins, F.G.S., 379 Euston-road, N.W.
Jan. 26, 1866	Johnson, R. G., Horbury-villa, Ladbroke-square, Notting-hill, W.
Mar. 24, 1871	Johnstone, James, jun., 14 Lordship-park, Green-lanes, N.
Mar. 19, 1869	Jonas, L. E., 13 Canterbury-villas, Maida-vale, N.W.
Nov. 25, 1870	Jones, Major Lewis, United Service Club, Pall-mall, S.W.
Dec. 18, 1868	Jordan, James B., 11 Grafton-sq., Clapham, S.W.
Oct. 26, 1866	Kemp, Robert, 25 Junction-rd., Upper Holloway, N.
Oct. 26, 1866	Kent, W. S., F.R.M.S., F.Z.S., The Geological Department, British Museum.
Aug. 23, 1867	Kiddle, Edward, The War Office, Pall-mall, S.W.
Mar. 19, 1869	Kilsby, Thomas W., Upper Fore-st., Edmonton, N.
July 7, 1865	King, G. H., 190 Great Portland-street, W.
July 22, 1870	King, Henry, 65 Myddelton-square, E.C.
Dec. 23, 1870	King, Robert, Fern-house, Upper Clapton, E.
April 26, 1867	Kirk, Joseph, 11 Blossom-st., Norton Folgate, N.E.
June 24, 1870	Knaggs, Henry G., M.D., 49 Kentish-town-road, N.W.
Oct. 23, 1868	Knevett, S., 18 Montague-street, Russell-sq., W.C.
Nov. 25, 1870	Ladd, Wm., F.R.A.S., 12 Beak-street, Regent-street, W.
July 27, 1866	Lambert, T. J., 151 Highbury New-park, N.

Date of Election.	
Nov. 23, 1866	Lambert, W., 4 New Basinghall-street, E.C.
Aug. 24, 1866	Lampray, John, F.R.G.S., F.A.S.L., F.R.M.S., 16 Camden-square, N.W.
Mar. 22, 1867	Lancaster, Thos., Bownham-house, Stroud, Gloucestershire.
Dec. 28, 1866	Langrish, H., 250 Pentonville-road, N.
Aug. 4, 1865	LANKESTER, EDWIN, M.D., F.R.S., F.L.S., F.R.M.S., Melton House, Child's-hill, Hampstead, N.W.
April 26, 1872	Law, Rev. William, Marston Trussell, Market Harborough.
June 25, 1869	Layton, Charles E., 8 Upper Hornsey-rise, N.
Dec. 22, 1871	Lea, Henry, 1 Horningsham-villas, Junction-road, Upper Holloway, N.
Aug. 28, 1868	LEAF, C. J., F.L.S., F.R.M.S., &c. (*President of the Old Change Microscopical Society*), Old Change, E.C.
Mar. 19, 1869	LEE, HENRY, F.L.S., F.R.M.S., &c. (*Vice-President*), The Waldrons, Croydon.
Aug. 25, 1871	Leftwich, R. Winnington, 2 Tufnel Park West, Holloway, N.
Oct. 25, 1867	Leifchild, J. R., M.A., 42 Fitzroy-street, Fitzroy-square, W.
Sept. 22, 1865	Leighton, W. H., 2 Merton-place, Chiswick, W.
June 25, 1869	Lemmon, Benj., 61 Hungerford-road, Islington, N.
May 28, 1869	Letts, Edmund A., South View, Black Gang, Isle of Wight.
July 26, 1872	Levien, Chas. N., 3 Great Tower-street, E.C.
Mar. 22, 1867	Lewinsky, John, 13 Frith-street, Soho, W.
Jan. 22, 1869	Lewis, Louis, M.R.C.S., 1 Rutland-street, Regent's-park, N.W.
April 27, 1866	Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 1 Lowndes-terrace, Knightsbridge, S.W.
Nov. 24, 1871	Lewis, T. Preston, 1 Alfred-place, Bedford-square, W.C.
June 26, 1868	Lindley, W., jun., Kidbrook-terrace, Blackheath, S.E.
June 25, 1869	Linford, John S., 146 Holborn-bars, W.C.
Dec. 17, 1869	Lloyd, Thos., 17 Holles-street, Cavendish-sq., W.

Date of Election.	
Nov. 24, 1865	Loam, Michael, Hampton, Middlesex, S.W.
May 26, 1871	Locke, John, 65 Camden-st., Camden Town, N.W.
April 23, 1869	Long, Henry, 90 High-street, Croydon.
Jan. 26, 1866	Lord, J. K., F.Z.S., Elm-house, Denmark-hill, S.E.
Nov. 24, 1865	Lovibond, J. W., F.R.M.S., St. Anne-street, Salisbury.
Sept. 22, 1865	Lovick, T., Board of Works, Spring-gardens, S.W.
May 28, 1869	Lowe, Henry W., Heathfield, Sydenham-hill, S.E.
Dec. 18, 1868	Lowne, Benjamin Thompson, M.R.C.S., 99 Guildford-street, Russell-square, W.C.
April 27, 1866	Loy, W.T., F.R.M.S., 9 Garrick-chambers, Garrick-street, W.C.
Jan. 24, 1868	Macdonald, J., M.D., 68 Up. Kennington-lane, S.E.
Nov. 25, 1870	McHardy, M. M., St. George's Hospital, S.W.
Nov. 23, 1866	McIntire, S. J., F.R.M.S., 22 Bessborough-gardens, S.W.
Jan. 26, 1872	McKechnie, J. Hamilton, M.D., 16 Princes-street, Cavendish-square.
Oct. 25, 1867	McLeod, R. G., Cowley Arms, Addison-place, Brixton-road, S.W.
May 22, 1868	McVean, W., 18 Wood-street, E.C.
June 14, 1865	Marks, E., 2 Brunswick-terrace, Harringay-road, Hornsey, N.
Mar. 22, 1872	Marquand, Ernest D., 45 Arundel-square, Barnsbury, N.
June 26, 1868	Martin, James, 110 Regent-street, W.
Dec. 27, 1867	Martinelli, A., 106 Albany-street, N.W.
Oct. 25, 1867	Marwood, W. G. H., 68 Downham-road, Kingsland, N.
Dec. 22, 1865	Mason, J., Hampton, Middlesex, S.W.
April 26, 1867	Matthews, G. K., St. John's-lodge, Beckenham, Kent, S.E.
May 28, 1869	Matthews, Henry, 60 Gower-street, W.C.
Oct. 26, 1866	Matthews, John, M.D., 4 Mylne-street, Myddelton-square, E.C.
June 28, 1867	Matthews, Peter, L.D.S., F.Z.S., F.R.M.S., 11 Welbeck-street, W.

Date of Election.	
Sept. 24, 1869	Matthews, William, 374 Camden-road, N.
Aug. 27, 1869	Mavor, William Samuel, 91 Park-street, Grosvenor-square, W.
May 26, 1871	May, John William, F.R.M.S., Arundel-house, Percy-cross, Fulham, S.W.
Mar. 22, 1867	Meacher, John W., 10 Hillmarten-road, Camden-road, N.
May 27, 1870	Medlock, Henry, M.D., 22 Tavistock-square, W.C.
Dec. 18, 1868	Mestayer, Richard, F.L.S., F.R.M.S., 7 Buckland-crescent, Belsize-park, N.W.
May 28, 1869	Millar, John, M.D., F.L.S., G.S., R.M.S., &c., Bethnal-house, Cambridge-road, N.E.
June 26, 1868	Milledge, Alfred, 4 Upper Winchester-road, Stanstead-road, Forest-hill, S.E.
Sept. 28, 1866	Miller, Benj., F.R.M.S., 4 Denmark-hill, S.E.
July 7, 1865	Millett, F. W., 15 Alfred-street, River-terrace, N.
June 25, 1869	Moggridge, Matthew, F.G.S., care of Rev. M. W. Moggridge, Long Ditton, Kingston-on-Thames, Surrey.
May 25, 1866	Moginie, W., F.R.M.S., 14 Riding-house-street, W.
Mar. 27, 1868	Moore, Daniel, M.D., Hastings-lodge, Victoria-road, Upper Norwood, S.E.
Oct. 27, 1865	Morrieson, Colonel R., F.R.M.S., Oriental Club, Hanover-Square, W.
July 26, 1867	Mott, H. H., 47 Union-grove, Clapham, S.W.
April 24, 1868	Mummery, J. Rigden, F.L.S., F.R.M.S., 10 Cavendish-place, W.
April 24, 1868	Mummery, J. Howard, 10 Cavendish-place, W.
Dec. 18, 1868	Mundie, George, M.R.C.S., 93 Richmond-road, Dalston, N.E.
Jan. 25, 1867	Murray, R. C., 69 Jermyn-street, St. James's, S.W.
Sept. 27, 1867	Nash, Thompson, 14 Douglas-rd., Canonbury-sq., N.
Mar. 23, 1866	Nation, W. J., 30 King-square, Goswell-road, E.C.
Mar. 24, 1871	Nelson, James, 2 Durham-place, Lambeth-road, S.E.
Jan. 26, 1872	Newton, Edwin Tulley, Geological Museum, Jermyn-street, S.W.

Date of Election.

July 26, 1872	Nicoll, Geo., jun., 4 Kingston-villas, Buckhurst-hill, Essex.
July 7, 1865	Nicholson, D., 51 St. Paul's-churchyard, E.C.
Dec. 22, 1865	Nunn, C. G., Hampton, Middlesex, S.W.
April 26, 1867	Oakley, J. J., F.R.M.S., 183 Piccadilly, W.
Mar. 27, 1868	Oakeshott, John, High-street, Highgate, N.
May 26, 1871	Oriel, Chas. F., Oak-villa, Mattock-lane, Ealing, W.
Dec. 27, 1867	Osborn, C. E., 28 Albert-road, St. John's-ville, Highgate, N.
Dec. 27, 1867	Oxley, F., 3 Crosby-square, Bishopgate, E.C.
Nov. 27, 1868	Parker, T., 10 Brunswick-square, Camberwell, S.E.
April 22, 1870	Parker, Thos. J., 36 Claverton-street, S.W.
Dec. 17, 1869	Parker, William, M.D., 133 Grange-road, Bermondsey, S.E.
Oct. 27, 1871	Parsons, Fred. Anthony, 18 London-street, City, E.C.
June 25, 1869	Pass, H., 11 Spring-terrace, Wandsworth-road, S.W.
May 26, 1871	Paxton, Rev. W. Archibald, M.A., Otterden Rectory, Faversham, Kent.
May 24, 1867	Pearce, G. T., 39 Clapham-road, S.W.
Feb. 23, 1872	Pearse, W. E. Grindley, L.R.C.P., 24 Bessborough-gardens, South Belgravia, S.W.
May 24, 1867	Pearson, John, 212 Edgware-road, W.
May 28, 1869	Pepler, W. B., Market Lavington, Wilts.
Oct. 25, 1867	Peppin, S. H., 25 Princes-st., Leicester-square, W.
Nov. 26, 1869	Perken, Edmund, 24 Hatton-garden, E.C.
July 23, 1869	Perry, F. J., 148 Church-road, Islington, N.
May 26, 1871	Pett, Edward Pattison, Lynden-villa, Tulse-hill, S.W.
Oct. 27, 1865	Pickard, J. F., 1 Bloomsbury-street, W.C.
Dec. 23, 1870	Piggott, G. W. Royston, B.A., M.D., 2 Lansdown-crescent, Kensington-park, W.
Mar. 22, 1872	Pinker, R. H., Regency-square, Brighton.
Jan. 22, 1869	Pillischer, M., F.R.M.S., 88 New Bond-street, W.

Date of Election.	
Nov. 24, 1871	Pitts, Fred., Harvard-house, St. John's-hill, Clapham.
June 25, 1869	Pocock, Lewis, jun., 70 Gower-street, W.C.
July 23, 1866	Pocock, Thos. Willmer, 10 Ampthill-square, N.W.
Nov. 23, 1866	Potter, G., F.R.M.S., 42 Grove-road, Upper Holloway, N.
June 22, 1866	Powe, I., St. John's, Richmond, Surrey.
May 25, 1866	Powell, Hugh, F.R.M.S., 170 Euston-road, N.W.
July 7, 1865	Powell, Thomas, 18 Doughty-street, Mecklenberg-square, W.C.
Oct. 26, 1866	Praill, Edward, 39 Mornington-road, N.W.
Dec. 27, 1867	Preston, H. B., 1 Devonshire-road, Liverpool.
June 24, 1870	Preston, Francis W. H., 30 Warwick-gardens, Kensington, W.
Jan. 26, 1872	Price, F. G. Hilton, Temple-bar, E.C.
Feb. 26, 1869	Prichard, Thomas, M.D., Abbington Abbey, Northampton.
Nov. 27, 1868	Pritchett, Benjamin, 131 Fenchurch-street, E.C.
July 26, 1867	Pritchett, Francis, 131 Fenchurch-street, E.C.
April 23, 1869	Quekett, Arthur Edwin, 13 Delamere-crescent, Westbourne-square, W.
April 23, 1869	Quekett, Alfred J. S., 13 Delamere-crescent, Westbourne-square, W.
April 23, 1869	Quekett, Rev. William, The Rectory, Warrington.
Feb. 23, 1866	Quick, George E., 109 Long-lane, Bermondsey, S.E.
Oct. 26, 1866	Rabbits, W. T., Selwood, Mayow-road, Forest-hill, S.E.
Nov. 23, 1866	Radermacher, J. J., 21 Tregunter-road, The Boltons, Brompton, S.W.
Sept. 24, 1869	Radcliffe, J. D., 93 Albion-road, Dalston.
Oct. 26, 1866	Ramsbotham, J. M., M.D., 15 Amwell-street, Pentonville, E.C.
Oct. 26, 1866	Ramsden, Hildebrand, M.A., F.L.S., F.R.M.S., Forest-rise, Walthamstow, N.E.
Aug. 28, 1868	Rance, T. G., Widmore-lane, Bromley, Kent.

Date of Election.

May 22, 1868	Rawles, W., 64 Kentish-town-road, N.W.
Oct. 28, 1870	Rean, Walter, Woodstock-road, Poplar, E.
July 7, 1865	Reeves, W. W., F.R.M.S., 37 Blackheath-hill, Greenwich, S.E.
May 26, 1871	Richards, Edward, F.R.M.S., 289 Camberwell-new-road, S.E.
Mar. 25, 1870	Richardson, Thos. Hyde, Raleigh-lodge, Devonshire-road, Forest-hill.
Jan. 24, 1868	Richardson, C. J., 44 Duncan-terrace, Islington, N.
Dec. 22, 1865	Richardson, C. T., M.D., 36 Dorset-square, N.W.
Feb. 23, 1866	Rixon, F., F.R.M.S., Loats-road, Clapham-park, S.W.
June 25, 1869	Roberts, John H., F.R.C.S., F.R.M.S., 20 New Finchley-road, St. John's-wood, N.W.
April 26, 1872	Roberts, S. Hackett, 355 Walworth-road, S.E.
May 22, 1868	Rogers, John, Elm-avenue, New Basford, near Nottingham.
Oct. 26, 1866	Rogers, Jos. R., 12 Bellefield-terrace, Bellefield-road, Stockwell, S.W.
Oct. 26, 1866	Rogers, Thomas, Mortlock-house, Loughborough-road, Brixton, S.W.
April 24, 1868	Rogerson, John, F.R.M.S., care of Mr. H. Crouch, 51 London-wall, E.C.
Mar. 22, 1872	Rolfe, Charles Spencer, 26 Gunter-grove, West Brompton.
May 22, 1868	Roper, F. C. S., F.L.S., F.G.S., F.R.M.S., Palgrave-house, Eastbourne, Sussex.
July 24, 1868	Rowe, James, jun., M.R.C.V.S., 65 High-street, Marylebone, W.
Oct. 26, 1866	Rowlett, John, 10 Crozier-street, S.E.
June 14, 1865	Ruffle, G. W. (*Curator*), 131 Blackfriars-road, S.E.
Oct. 27, 1865	Russell, James, 4 Lansdowne-terrace, London-fields, Hackney, N.E.
Oct. 26, 1866	Russell, Joseph, F.R.M.S., Cumberland-lodge, Brixton-hill, S.W.
May 22, 1868	Russell, Thomas D., Patson-villa, Canterbury-road, Brixton, S.W.
Feb. 22, 1867	Rutter, H. Lee, 1 St. Barnabas-villas, Lansdowne-circus, South Lambeth, S.W.

Date of Election.	
Dec. 17, 1869	Salmon, John, 24 Seymour-street, Euston-square.
Dec. 17, 1869	Sanders, Gilbert, Brockley-on-the-Hill, Monkstown, Dublin.
Nov. 22, 1867	Sanford, John, 30 Willes-road, Kentish-town, N.W.
July 28, 1871	Sansom, Arthur Ernest, M.D., 29 Duncan-terrace, Islington, N.
July 26, 1872	Sargent, J., jun., Fritchley, near Derby.
July 26, 1872	Sarll, John, De Beauvoir House, Englefield-rd., N.
May 22, 1867	Scatliff, John Parr, M.D., 132 Sloane-street, S.W.
May 24, 1872	Schloesser, Ernest, 9 College-hill, Cannon-st., E.C.
May 28, 1869	Scoble, Samuel W., 25 James-street, Covent-garden, W.C.
May 24, 1872	Sequeira, H. L., M.R.C.S., 1 Jewry-street, Aldgate, E.C.
July 27, 1868	Sewell, Richard, Prince's-road, Lambeth, S.E.
July 27, 1866	Sharpey, W., M.D., F.R.S., 33 Woburn-place, W.C.
Oct. 22, 1869	Shaw, Wm. Forster, 50 Threadneedle-street, E.C.
Jan. 22, 1869	Sheehy, William H., M.D., 4 Claremont-square, N.
May 24, 1872	Sheehy, W. H. Podmore, 4 Claremont-square, N.
May 26, 1871	Sigsworth, J. C., 21 Clarendon-road, Holland-park, W.
Aug. 23, 1867	Simmons, James, J., L.D.S., F.R.M.S., 18 Burton-crescent, W.C.
May 28, 1869	Simonds, Professor J. B., F.R.M.S., Royal Veterinary College, N.
Dec. 28, 1866	Simpson, G. Wharton, 36 Canonbury-park South, N.
Mar. 27, 1868	Simson, Thos., The Laurels, Courtyard, Eltham.
May 28, 1869	Sketchley, H. G., 10 Ampthill-square, N.
Dec. 28, 1866	Slade, J., 100 Barnsbury-road, N.
Oct. 23, 1868	Smart, William, 27 Aldgate, E.
Mar. 22, 1872	Smart, Harry, 11 Paragon-terrace, Hackney.
May 25, 1866	Smith, Alpheus, (*Librarian*), 42 Choumert-road, Rye-lane, Peckham.
Mar. 25, 1870	Smith, Francis Lys, 3 Grecian-cottages, Crown-hill, Norwood.
Oct. 26, 1868	Smith, H. Ambrose, 2 King William-st., City, E.C.
June 26, 1868	Smith, James, F.L.S., F.R.M.S., 11 Willow-cottages, Canonbury, N.

Date of Election.	
May 22, 1868	Smith, James John, F.R.M.S., 56 Tollington-road, N.
Dec. 23, 1870	Smith, Joseph A., London and County Bank, Newington, S.E.
April 23, 1869	Smith, Vernon, 37 Tavistock-square, W.C.
June 24, 1870	Smith, William, 1 Down-place, Hammersmith, W.
April 24, 1868	Snellgrove, W., 22 Surrey-square, S.E.
Sept. 22, 1865	Southwell, C., 44 Princes-street, Soho, W.
Dec. 18, 1868	Sowerby, D., 38 Albert-road, Dalston, N.E.
May 22, 1868	Spencer, John, Brook's Bank, 81 Lombard-street, City, E.C.
Nov. 23, 1866	Spurrell, F. C. J., F.R.M.S., Belvidere, Kent, S.E.
April 22, 1870	Stanley, Wm. Ford, Railway-approach, London-bridge, S.E.
May 26, 1871	Stapleton, Henry, 55 Beresford-road, Highbury-new-park, N.
Mar. 24, 1865	Starling, Benjamin, 11 Gray's-inn-square, W.C.
Feb. 23, 1872	Stevens, C. R., 7 Ashby-road, Canonbury, N.
Aug. 24, 1866	Steward, J. H., F.R.M.S., 406 Strand, W.C.
Mar. 19, 1869	Stokes, Frederick, 31 Lincoln's-inn-fields, W.C.
Oct. 27, 1871	Stuart, David John, 39 Marquess-road, Canonbury, N.
July 1, 1866	Suffolk, W. T., F.R.M.S., Claremont-lodge, Park-street, Camberwell, S.E.
Nov. 22, 1867	Swainston, J. T., 14 Loraine-place, Holloway, N.
Nov. 24, 1865	Swansborough, E., 20 John-street, Bedford-row, W.C.
June 24, 1870	Swain, Ernest, 89 Ladbroke-road, W.
Dec. 18, 1868	Swift, James, 43 University-street, W.C.
June 26, 1868	Syms, F. R., 4 Acacia-villas, Upper Richmond-road, Putney, S.W.
May 24, 1872	Symons, Henry E., F.R.M.S., St. Bartholomew's-hospital, E.C.
Nov. 25, 1870	Tafe, John Forwood, 34 Old Broad-st., City, E.C.
May 22, 1868	Tatem, J. G., Russell-street, Reading.
Aug. 25, 1871	Taverna, The Count, Joseph, 25 Trafalgar-square, Brompton, S.W.

Date of Election.	
Dec. 22, 1865	Terry, J., 109 Borough-road, S.E.
May 28, 1869	Thairlwall, F. J., 169 Gloucester-road, Regent's-park, N.W.
July 23, 1869	Thin, James, Ormiston-lodge, Claremont-place, Brixton-road, S.W.
Feb. 24, 1871	Thornthwaite, W. H., jun., 122 Newgate-st., E.C.
Jan. 24, 1868	Tomkins, Samuel Leith, 26 Buckland-crescent, Belsize-park, N.W.
June 23, 1871	Topping, Amos, 28 Charlotte-street, Caledonian-road, N.
July 26, 1872	Townsend, J. S., F.R.M.S., 59 London-road, Croydon.
April 26, 1872	Tozer, Edward, Ivy-lodge, Woodford, Essex.
July 24, 1868	Tulk, John A., M.D., Spring-grove, Isleworth, W.
July 24, 1868	Tulk, John A., F.R.M.S., &c., Firfield, Addlestone, Weybridge.
July 26, 1867	Turnbull, Joseph, 1 Clifton-villas, Highgate-hill, N.
June 25, 1869	Turner, R. D., Chafford, Tunbridge.
Mar. 27, 1868	Tuson, Professor Richard V., Royal Veterinary College, N.W.
May 26, 1871	Unwin, Wm. Cawthorne, B. Sc., A.I.C.E., Homerton College, E.
July 27, 1866	Veitch, Harry, F.H.S., The Royal Exotic Nursery, King's-road, Chelsea, S.W.
Feb. 23, 1866	Walker, A., M.D., 17 Throgmorton-street, E.C.
May 28, 1869	Walker, Henry, 100 Fleet-street, E.C.
June 26, 1868	Walker, J. W., Fairfield-house, Watford.
Dec. 18, 1868	Waller, Arthur, F.R.M.S., 11 Aberdeen-park, Highbury, N.
May 22, 1868	Waller, J. G., 68 Bolsover-street, Portland-rd., W.
Oct. 27, 1865	Wallis, George, South Kensington Museum, S.W.
Aug. 26, 1870	Warburton, Samuel, Merton-villa, New-road, Lower Tooting, S.W.

Date of Election.	
Dec. 22, 1871	Ward, Daniel, 26 Coleman-street, Woolwich.
Nov. 22, 1867	Ward, F. H., Springfield-house, near Tooting, Surrey.
Dec. 18, 1868	Warner, Alfred, 47 Falmouth-st., Trinity-sq., S.E.
Feb. 26, 1869	Warner, William, 51 Bookham-street, New North-road, N.
May 25, 1866	Warrington, H. R., 7 Royal Exchange, Cornhill, E.C.
Oct. 27, 1865	Watkins, C. A., 10 Greek-street, Soho, W.
Sept. 22, 1865	Watson, T. G., 43 Poland-street, Oxford-street, W.
Sept. 25, 1868	Waugh, J. W. Spencer, 4 Maitland-park-villas, Haverstock-hill, N.W.
Dec. 28, 1866	Way, T. E., 65 Wigmore-street, W.
Jan. 22, 1869	Webb, George, 3 Crosby-square, Bishopsgate, E.C.
Dec. 22, 1871	Webber, John, Limes-villas, Croxted-road, Dulwich.
May 24, 1867	Weeks, A. W. G., 18 Gunter's-grove, Chelsea, S.W.
Dec. 28, 1866	Wheldon, W., F.R.M.S., 58 Great Queen-street, W.C.
April 23, 1869	White, Charles Frederick, F.R.M.S., 42 Windsor-road, Ealing.
Feb. 26, 1868	White, Francis W., 2 Gipsy-hill-villas, Norwood, S.E.
May 22, 1868	White, T. Charters, M.R.C.S., F.R.M.S. (*Secretary*), 32 Belgrave-road, S.W.
May 24, 1867	White, W., F.R.M.S., Cawston, Sandown, Isle of Wight, N.
July 24, 1868	Wight, James F., F.R.M.S., Gatcombe-villa, Croxted-road, West Dulwich, S.E.
May 22, 1868	Wigner, John M., B.A., B.Sc., 16 Grove-hill-terrace, Grove-lane, Camberwell, S.E.
Oct. 28, 1870	Williams, Martin G., 2 Highbury-crescent, N.
Mar. 24, 1871	Williams, George, 6 St. John's-park, Upper Holloway, N.
July 28, 1871	Williams, Robert Pakenham, 3 Whittington-grove, Highgate-hill, N.
Jan. 25, 1867	Willsworth, H., 7 Whittington-terrace, Upper Holloway, N.
Feb. 23, 1866	Wilshin, J., 12 Totford-place, Neckinger, Bermondsey, S.E.

Date of Election.	
Feb. 22, 1867	Wilson, Frank, 110 Long-acre, W.C.
April 24, 1868	Withall, Henry, 1 The Elms, St. John's-road, Brixton, S.W.
May 28, 1869	Wood, Charles H., F.C.S., 25 Devonshire-road, Holloway, N.
Sept. 22, 1865	Wood, E. G., 74 Cheapside, E.C.
Aug. 27, 1869	Woods, W. Fell, 1 Park-hill, Forest-hill, S.E.
Oct. 25, 1867	Worthington, Richard, Champion-park, Denmark-hill, S.E.
Nov. 23, 1866	Wright, Edw., 89 Shepherdess-walk, E.C.
Aug. 4, 1865	Wyatt, C. C., 9 North Audley-street, W.
Oct. 26, 1866	Yeats, Christopher, Mortlake, Surrey, S.W.
Sept. 23, 1870	Yeoman, L. C. B., 21 Gutter-lane, E.C.
April 26, 1867	Young, J. T., 32 Mount-street, New-road, White-chapel, E.

Members of the Club changing their address, will oblige by communicating their new direction to the Secretary without delay.

RULES.

I.—That "The Quekett Microscopical Club" hold its meetings at University College, Gower Street, on the fourth Friday Evening in every month, at Eight o'clock precisely, or at such other time or place as the Committee may appoint.

II.—That the business of the Club be conducted by the President, four Vice-Presidents, the Treasurer, the Honorary Secretary, the Honorary Secretary for Foreign Correspondence, and a Committee of twelve other members. Six to form a quorum. That the Editor of the Journal be *ex officio* an additional member of the Committee. That the President, Vice-Presidents, Treasurer, and two Secretaries, with four senior members of the Committee (by election) retire annually, but be eligible for re-election.

III.—That at the ordinary Meeting in June, nominations be made of Candidates to fill the offices of Vice-Presidents and vacancies on the Committee. That such nominations be made by resolutions duly moved and seconded, no Member being entitled to propose more than one Candidate. That in the event of such nominations exceeding one half more than the number of vacant offices, the Candidates be reduced by show of hands to such proportion. That the President, Treasurer, Honorary Secretary, and Honorary Secretary for Foreign Correspondence be nominated by the Committee. That a list of all nominations made as above be printed in alphabetical order upon the ballot paper. That at the Annual General Meeting in July all the above officers be elected by ballot from the candidates named in the lists, but any member is at liberty to substitute on his ballot-paper any other name or names in lieu of those nominated for the offices of President, Treasurer, Honorary Secretary, and Honorary Secretary for Foreign Correspondence.

IV.—That in the absence of the President and Vice-Presidents the Members present at any ordinary Meeting of the Club elect a Chairman for that evening.

V.—That every Candidate for Membership be proposed by two or more Members, who shall sign a certificate (see Appendix) in recommendation of him—one of the proposers from personal knowledge. The certificate shall be read from the chair, and the Candidate therein recommended ballotted for at the following Meeting. Three black balls to exclude.

VI.— That the society include not more than twenty Foreign Honorary Members, elected by the Members by ballot upon the recommendation of the Committee.

VII.—That the Annual Subscription be Ten Shillings, payable in advance on the 1st of July, but that any Member elected in May or June be exempt from subscription until the following July. That any Member desirous of compounding for his future subscription may do so at any time by payment of the sum of Ten Pounds; all such sums to be duly invested in such manner as the Committee shall think fit. That no person be entitled to the full privileges of the Club until his subscription shall have been paid; and that any Member omitting to pay his subscription six months after the same shall have become due (two applications in writing having been made by the Treasurer) shall cease to be a Member of the Club.

VIII.—That the accounts of the Club be audited by two Members, to be appointed at the ordinary Meeting in June.

IX.—That the Annual General meeting be held on the fourth Friday in July, at which the Report of the Committee on the affairs of the Club, and the Balance Sheet duly signed by the Auditors shall be read. Printed lists of Members nominated for election as President, Vice-Presidents, Treasurer, Secretaries, and Members of the Committee having been distributed, and the Chairman having appointed two or more Members to act as Scrutineers, the Meeting shall then proceed to ballot. If from any cause these elections, or any of them, do not take place at this Meeting, they shall be made at the next ordinary Meeting, of the Club.

X.—That at the ordinary Meetings the following business be transacted:—The minutes of the last Meeting shall be read and confirmed; donations to the Club since the last Meeting announced

and exhibited; ballots for new Members taken; papers read and discussed; and certificates for new Members read; after which the Meeting shall resolve itself into a conversazione.

XI.—That any Member may introduce a Visitor at any ordinary meeting, who shall enter his name with that of the Member by whom he is introduced, in a book to be kept for the purpose.

XII.—That no alteration be made in these Laws, except at an Annual General Meeting, or a Special General Meeting called for that purpose; and that notice in writing of any proposed alteration be given to the Committee, and read at the ordinary Meeting at least a month previous to the Annual or Special Meeting, at which the subject of such alteration is to be considered.

APPENDIX.

Form of Proposal for Membership in

Quekett Microscopical Club.

Mr.
of
being desirous of becoming a Member of this Club, we beg to recommend him for election.

(*on my personal knowledge*).

This Certificate was read 187
The Ballot will take place 187

RULES FOR THE EXCHANGE OF SLIDES.

I. That all Slides be deposited with the Exchange Committee.

II. That not more than two similar Slides be placed in the Exchange Box at one time by any one Member.

III. That the Slides be classified by the Committee into Sections, numbered according to quality.

IV. Members to select from the class in which their Slides are placed, at the ordinary meeting of the Club.

V. Members may leave the selection to the Exchange Committee, if they prefer it.

VI. Slides once exchanged cannot be exchanged again.

VII. A Register shall be kept, in which the Slides deposited shall be entered and numbered, with the date of receipt, and in which exchanges shall also be noted.

VIII.—All expenses incurred in the transmission of Slides or in correspondence respecting them, to be borne by the Member on whose account such charges may be incurred.

Parcels may be addressed—

Mr. T. Charters White,
192, Piccadilly,
London, W.
[Exchange.]

Note.—As much inconvenience frequently arises from the breakage of Slides in transmission through the Post, the following method is recommended:—Pack the Slides in a small wooden box, which can be obtained of any Optician, tie it securely with string and attach a slip of parchment to one end, sufficiently large to receive the Postage Stamps, Address, and local Post-office Stamps during transmission.

If paper be used as a wrapper to the box, the colour should be *black*.

When twelve or more Slides are sent, they should be packed in a racked box and forwarded by Railway.

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB,

AT

UNIVERSITY COLLEGE, GOWER STREET, LONDON.

1872.—August		9	23
	September	13	27
	October	11	25
	November	8	22
	December	13	27
1873.—January		10	24
	February	14	28
	March	14	28
	April	*	25
	May	9	23
	June	13	27
	July	11	25

*Good Friday—No Meeting.

The Ordinary Meetings will be held on the fourth Friday Evenings, at Eight o'clock.

Extra Meetings for Conversation and Exhibition of Objects only, will be held on the *second* Friday of every month, at 7 o'clock, until further notice.

The Annual General Meeting will be held July 25th, 1873, at 8 o'clock, for Election of Officers and other business.

Offices, 192, Piccadilly, W.

Q. M. C.

EXCURSIONS, 1872.

April 6th	WANDSWORTH COMMON. To meet at Clapham Junction, at 3 p.m.
April 20th	LEA BRIDGE. To meet at Bishopsgate Station.
May 4th	WILLESDEN, returning by Hendon. To meet at the Willesden Junction at 3.30 p.m.
May 18th	CHISELHURST. To meet at Charing Cross Station.
June 1st	ELSTREE. To meet at St. Pancras Station, at 1.30 p.m.
June 15th	SNARESBROOK. To meet at Fenchurch Street Station.
June 19th	EXCURSIONISTS' ANNUAL DINNER. Arrangements will be duly announced.
June 29th	BARNET (for TOTTERIDGE), returning by East End, Finchley. To meet at King's Cross Station, G.N.
July 13th	CATERHAM JUNCTION. To meet the Croydon Microscopical Society, Charing Cross Station.
July 15th	SOUTHEND, Day Excursion. To meet at the Fenchurch Street Station, the first Train after 10 a.m.
July 27th	BROMLEY (for KESTON). To meet at Ludgate Hill Station.
Aug. 10th	HAMPTON COURT. To meet at Waterloo Station (Main Line).
Aug. 24th	THAMES DITTON. To meet at Waterloo Station (Main Line).
Sept. 7th	NORTHFLEET (for SWANSCOMBE). To meet at Canon Street Station.
Sept. 21st	BARNES. To meet at Waterloo Station (Richmond line).
Oct. 5th	VICTORIA DOCKS. To meet at Fenchurch Street Station.

The time of departure from Town, unless otherwise specified, will be THE FIRST TRAIN AFTER TWO O'CLOCK.

F. W. Gay,
F. Oxley,
W. W. Reeves,
W. T. Suffolk,
Excursion Committee.

T. Charters White, Hon. Secretary.
Offices, 192, Piccadilly.

EIGHTH REPORT

OF THE

QUEKETT MICROSCOPICAL CLUB,

AND

LIST OF MEMBERS.

MEETING AT UNIVERSITY COLLEGE, LONDON, ON THE SECOND AND FOURTH FRIDAYS OF EVERY MONTH.

OFFICES: 192, PICCADILLY,
LONDON.

July 1873.

(*Extract from original Prospectus, July* 1865.)

" The want of such a Club as the present has long been felt, wherein " Microscopists and students with kindred tastes might meet at stated periods " to hold cheerful converse with each other, exhibit and exchange specimens, " read papers on topics of interest, discuss doubtful points, compare notes of " progress, and gossip over those special subjects in which they are more or " less interested: where, in fact, each member would be solicited to bring his " own individual experience, be it ever so small, and cast it into the treasury " for the general good. Such are some of the objects which the present Club " seeks to attain. In addition thereto it hopes to organize occasional Field " Excursions, at proper seasons, for the collection of living specimens, to " acquire a Library of such books of reference as will be most useful to " enquiring students; and, trusting to the proverbial liberality of Micro- " scopists, to add thereto a comprehensive Cabinet of Objects. By these, and " similar means, the Quekett Microscopical Club seeks to merit the support " of all earnest men who may be devoted to such pursuits; and, by fostering " and encouraging a love for Microscopical studies, to deserve the approval " of men of science and more learned societies."

OFFICERS AND COMMITTEE.

(Elected July 1873.)

President.

Dr. Robert Braithwaite, F.R.M.S., F.L.S.

Vice-Presidents.

Dr. Matthews, F.R.M.S.
T. W. Burr, F.R.A.S., F.R.M.S.
B. T. Lowne, F.R.C.S., F.R.M.S.
Chas. F. White, F.R.M.S.

Treasurer.

Robert Hardwicke, F.L.S.

Hon. Secretary.

John E. Ingpen, F.R.M.S.

Hon. Secretary for Foreign Correspondence.

M. C. Cooke, M.A.

Hon. Reporter.

Richard T. Lewis, F.R.M.S.

Committee.

W. H. Golding.
Thomas Greenish, F.R.M.S.
W. T. Loy, F.R.M.S.
B. Daydon Jackson.
Fred. Oxley.
J. M. Ramsbotham, M.D.
W. M. Bywater, F.R.M.S.
Frank Crisp, L.L.B., B.A., Lond., F.R.M.S.
H. F. Hailes.
F. H. P. Hind.
J. G. Waller.
T. C. White, M.R.C.S., F.R.M.S.

Hon. Librarian.

Alpheus Smith.

Hon. Curator.

G. W. Ruffle.

Excursion Committee.

F. W. Gay, F.R.M.S.
W. W. Reeves, F.R.M.S.
W. T. Suffolk, F.R.M.S.
F. Oxley.

Exchange (of Slides) Committee.

H. F. Hailes.
E. Marks.

Assistant Secretary.

E. Marks.

PAST PRESIDENTS.

	Elected.
EDWIN LANKESTER, M.D., F.R.S. - -	July, 1865.
ERNEST HART - - - - - - -	,, 1866.
ARTHUR E. DURHAM, F.L.S., &c. - -	,, 1867.
,, ,, - - - - -	,, 1868.
PETER LE NEVE FOSTER, M.A. - -	,, 1869.
LIONEL S. BEALE, M.B., F.R.S., &c. - -	,, 1870.
,, ,, - - -	,, 1871.
ROBERT BRAITHWAITE, M.D., F.L.S., &c. -	,, 1872.

REPORT OF THE COMMITTEE.

The publication of the Eighth Annual Report of the Quekett Microscopical Club affords the Committee the pleasing opportunity of again announcing its continued usefulness and prosperity. Originating in no spirit of antagonism to existing societies, but taking its stand simply upon the platform of a Student's Club, it has fully justified the prevision of its founders in meeting a want that was and is especially felt by those who first take up the study of the Microscope as a means of amusement, or an aid to the extension of Histological Science. While it continues to afford this aid, the usefulness and the popularity of the Quekett Microscopical Club will run side by side with its prosperity. By a reference to the extract from the original prospectus appended to this Report, the object of the founders of the Club may be seen, and it becomes the duty of your Committee to state how these objects have been provided for during the Eighth year of its existence.

Your Committee gladly avail themselves of this opportunity to thank the Council of University College for their continued liberality in allowing the Club to meet in the Library twice a month during the past year, and to assure

them that it is a privilege acknowledged and appreciated by all connected with the Club.

The Meetings continue well attended: that on *the Second Friday in each Month* proves still as attractive as it has been from its institution, and doubtless this arises from the means it affords for that intercommunication of friendly feeling, and that mutual assistance in Microscopical Manipulation which the Committee always desire to foster amongst the members, and which is the essence of a Club like the Quekett. Your Committee are glad to note an increasing taste for the exhibition of physiological and histological preparations on these evenings, and they would encourage this more and more as leading up to systematic work in a most useful and interesting department of Microscopical study. These meetings are held on the *Second* Friday of each month from 7 till 9.30 p.m.

The following Papers have been read during the past year at the Ordinary Meetings in addition to various verbal communications of great practical interest and utility:

On a new form of Class Microscope	Dr. Wm. A. Guy, F.R.S.
,, a Standard Dynamometer for ascertaining the magnifying power of Objectives . .	Mr. John E. Ingpen.
,, Comparative Study . .	Mr. D. E. Goddard.
,, a Bioplast	Dr. L. S. Beale, F.R.S.
,, a New Plan of Microscopical Injection by means of a Wolffe's Bottle . . .	Mr. J. T. English.
,, Diamond Writing as a Test for Objectives . . .	Mr. Wm. Webb.
,, the Histology of Plant Structures	Dr. R. Braithwaite, F.L.S.
,, the different forms of Eyepieces	Mr. John E. Ingpen.
,, a New Method of Dry Mounting	Mr. John Locke.

,, Nobert's Test Lines . .	Mr. Wm. Webb.
,, some Simple Appliances useful in Microscopical Observation	Mr. W. H. Golding.
,, a new form of Microscopical Super Stage . . .	Dr. Matthews.
,, the Ovulation of certain Hymenoptera	Mr. B. T. Lowne, F.R.C.S.
,, the Histology of Plant Structures (2nd Paper) . .	Dr. R. Braithwaite, F.L.S.
,, the Podura Scale beadings .	Dr. G. R. Piggott, B.A., &c.

The Club by the influx of new members during the year, and notwithstanding losses by death and resignations still numbers about 570, many of whom are constant attendants at its meetings and amongst its most ardent workers.

The Annual Soirée of the Club was held on Friday, March 21st, at University College, and was attended by upwards of 1000 visitors. The Club was re-inforced by the friendly assistance of the Croydon Microscopical Society, the Sydenham and Forest Hill Microscopical Club, the South London Microscopical Club, and by the leading opticians, who upon this as upon past occasions kindly exhibited the optical novelties of the year, and thereby added to the attractions of the evening; and your Committee desire to thank those gentlemen who thus contributed to make the Soirée a perfect success.

Your Committee have during the year gone carefully over the Slides in the Cabinet of the Club, and having removed a few that by lapse of time had become faulty, have labelled and classified the remainder, and now have the satisfaction of placing them again before the members for circulation. The following Slides have been presented to the Cabinet since the last Annual Meeting:

Mr. ALFRED ALLEN	. . .	2
„ M. BURGESS	. . . .	4
„ A. COTTAM	. . . .	9
„ WM. HAINWORTH	. . .	10
„ THOS. ROGERS	. . .	6
„ AMOS TOPPING	. . .	12
„ J. G. WALLER	. . .	6
„ JAMES WATKINS	. . .	57
„ T. C. WHITE	. . . .	24

These are not included in the Catalogue of the Slides published for the Club last year, but as the Cabinet by the kindness of members and their friends continues to be added to, it will doubtless be found necessary after a time to issue a supplementary list. In the mean time the Catalogue may be obtained at the Publishers, or of the Librarian on the evenings of meeting.

The following Books have been added by Donation and Purchase to the Library during the year:

Slack's Marvels of Pond Life	*Mr. J. W. Goodinge.*
Cobbold's Entozoa	*Mr. J. W. Groves.*
Pereira's Lectures on Polarised Light	*Mr. T. C. White.*
Taylor's Half-hours by the Sea Side	*Mr. E. P. Pett.*
Owen's Odontography	*By Purchase.*
Douglas and Scott's Hemiptera	*do.*
Allman's Freshwater Polyzoa	*Replaced.*
Popular Science Review	*Mr. Robt. Hardwicke.*
Monthly Microscopical Journal	*do.*
Science Gossip	*do.*
The American Naturalist	*In Exchange.*
The Lens	*do.*

Sundry Pamphlets and Proceedings of Scientific Societies.

It will be the endeavour of your Committee to enlarge this department of the Club's operations, and to make the Library

of the Club replete with works of reference on Microscopical Science as opportunities arise.

The question of the issue of the Journal has occupied much attention during the past year. It has been felt that the sum paid for the Journal in its late form was such that it might very well be reduced, and your Committee hope, by issuing it at such intervals as may be influenced by the amount of really good matter to be printed, not only to economise the funds of the Club, but also to present to the members an acceptable volume of valuable papers; and that members may be more frequently and speedily made acquainted with the proceedings of the Club, your Committee have under their consideration the issue of a Monthly Report, which they hope will meet with the approbation and appreciation of the members generally.

By the admirable arrangement of the Excursion Committee, to whom your Committee tender their warmest thanks, various favourite localities have been visited during the past year, and many pleasant opportunities afforded for union with the neighbouring Natural History Societies, some members of which may generally be found joining with those of the Club on these occasions; and your Committee would gladly see these Excursions more largely attended, as their advantage in the study of the various branches of Natural Science is undoubted.

A Donation presented to the Club in the past year seems to call for especial notice. It is very desirable to ascertain accurately the magnifying power of each objective used, because, though the approximate magnifying power is generally stated, yet there is found in practice such a vast difference between the objectives of different makers, although possessing the same nominal power, that it is advisable in all cases where our observations are made with a view to com-

parison with those of others, that we should be sure we are using the same amplification. Mr. John E. Ingpen has had made and presented to the Club a Standard Dynamometer for making these measurements, and for the use of the members under certain restrictions; and your Committee mention this to thank that gentleman for his liberal and valuable Donation. The Committee would also call attention to an evidence of warm interest in the welfare of the Club on the part of an absent member evinced by Mr. Henry Horncastle, who has forwarded a cheque for £3 to be expended by the Committee in any way they may deem most beneficial.

Your Committee cannot close this Report without thanking those gentlemen who, having kindly given their services in various departments of the Club's operations, have so efficiently carried out their work as materially to contribute to the general success. A change is contemplated in the office of Honorary Secretary—the duties of which, owing to the increased number of members, have now become very heavy. On the retirement of Mr. T. Charters White, who is unable from pressure of professional work to devote the great amount of time and attention necessary, it is proposed that a stipendary Assistant Secretary should be appointed, who will relieve the Honorary Secretary of part of the work, and be in other ways useful to the Club at large.

By a reference to the Treasurer's Report it will be seen that the financial condition of the Club is prosperous, the balance although not large being still on the right side; and your Committee cannot look back on the past year without seeing good ground upon which to base their congratulations to the members of the Quekett Microscopical Club.

PRESIDENT'S ADDRESS,

DELIVERED AT THE ANNUAL MEETING, JULY 25TH, 1873,

BY R. BRAITHWAITE, M.D., F.L.S., &c.

GENTLEMEN,—The time having arrived at which I am called upon to present to you the annual budget, my first duty is to return thanks to all connected with this Club, for the kindly feeling and friendship which I have experienced during the year now closing, and to congratulate the members on the continued prosperity which attends its progress.

Among the hundred or more Field Clubs and Associations of a kindred nature to our own, which exist in Great Britain at the present time, I think in point of numbers we are only surpassed by one, the Liverpool Field Club, founded in 1860, and reckoning some 640 members; but as I believe ladies are included in their list, this may be the reason of its numerical superiority. We may however safely conclude that the Quekett Club at the close of this its eighth year of existence, is in as sound and prosperous a condition as ever, for I would remind you that with clubs as with individuals there are periods of prosperity and decline, some going altogether to the wall, and others dragging on an inglorious existence. To the unceasing interest of a section of our members, whose faces are familiar to us at every meeting, and whose readiness

to assist all fresh recruits to our ranks is proverbial, I attribute chiefly our unimpaired vitality.

In looking back at the work achieved during the past year, beyond the pale of our Club, I feel how incompetent I am to bring before you a tithe of the results, and I must be content to record a few of the most noteworthy.

On the great question of the day—The Origin of Life—I can offer you no evidence based on personal investigation, but I may premise, that I am not a believer in Abiogenesis, and the position has certainly not been strengthened during the past year, but rather the contrary, for so far as I can judge, the experiments tend to prove, that if existing germs be destroyed, and the entry of new ones absolutely excluded, we fail to meet with even the irrepressible Bacteria. The first has been secured by more carefully bringing all parts of the interior surface of the vessels in contact with the hot liquid, the latter by the use of stoppers which act as filtering media, thus plugs of cotton wool were adopted by Dr. Roberts in his experiments at Manchester, and porous earthenware by Huizinga, which was luted into the necks of the vessels by means of asphalt: both have proved effective for the purpose intended.

To pass to another subject, I may point out that the facts established by Mr. Darwin, on the part played by insects in the fertilization of plants have been widely extended; nay, we may almost question whether any flowers have been constructed for their own independent self-impregnation, while many are obviously formed so as to prevent it, but offer wonderful contrivances for the process being effected by insects. The instances of Dimorphism and Trimorphism in flowers so ably investigated by this great naturalist are so curious that I cannot forbear referring to them. He showed that in numerous Primulas, some flowers have a stigma projecting at the throat of the corolla-tube, and no anthers

visible, while other flowers of the same species have anthers in the mouth of the corolla-tube, but the style does not reach half-way up; in these latter plants the pollen grains are larger than in the former, and more seeds are also produced. Experiment showed that short-styled plants produced the full amount of seeds, *only* when fertilized by pollen from long-styled plants, and this at once pointed to the necessity for insect agency, for both kinds of flowers, though perfect or complete with respect to the apparatus requisite for reproduction, are almost as dependent on extraneous assistance as if they were unisexual. Although absolute incapacity for fertilization by the pollen in their own flowers did not take place in *Primula*, yet in *Linum grandiflorum* the long-styled form was absolutely sterile when fertilized by its own pollen, but produced perfect seeds by pollen from the short-styled flowers. In connection with this subject, we also have the fact, that in many plants the anthers and stigmas in one flower are not matured at the same time, so as to be capable of acting on each other. If the anthers are mature first the condition is termed *protandrous*, if the stigmas are, it is called *protogynous;* and this state of things points clearly to insect agency being requisite for impregnation. Protandrism is much the most frequent, and Prof. Hildebrand has shown that the whole of the vast group of Compositæ come under this category; the styles elongate before the stigma is matured, and pushing through the tube of ripe anthers, brush off the pollen by means of the hairs with which they are provided, to be again removed by innumerable bees and flies that visit them, and again deposited on stigmas fit for their reception. Could there be a better example of Divine care, than that the means of reproduction should thus be extended over the widest area of time and space in the history of the individual, and of the mutual dependence of one large portion of creation on the services of another?

Among the literature of this department of Biological science during the past year, I would especially point out the work of Strasburger, "Die Coniferen und Gnetaceen;" these plants as you are aware constituting the Gymnosperms, and remarkable especially for the absence of an ovary, style and stigma. In this work which is accompanied by a quarto atlas of 26 plates, the author minutely describes their development and morphology, mixed up with which however is much theory of a fanciful nature, especially a genealogical tree, tracing back the conifers to Cycadeæ, which in turn he regards as derivatives of the extinct Lepidodendra, while the three little genera of Gnetaceæ are set down as the origin of Dicotyledons.

In the Smithsonian Contributions is a valuable monograph of the fresh water Algœ of North America, by Dr. H. C. Wood, with 21 quarto plates. The species are described in accordance with Rabenhorst's work, the Diatoms being omitted, and I refer to it, as it may be of use to us here, until we get some similar work on this department of our own Flora.

I would also set a high value on the labours of my friend Mr. Carruthers on fossil plants; the use of the microscope by this competent observer, having cleared away much of the obscurity which shrouded our knowledge of these extinct plants, which but too frequently have come down to us, only as fragments of skeletons infiltrated with extraneous material; the result has been a true interpretation of their structure and affinities, and in many cases the restoration of the complete individual by the combination of two or more supposed genera into a single species.

The last point under this head to which I would call attention, is a subject on which much has been written in Continental journals, without the matter having been settled. I allude to the extraordinary views propounded by Schwen-

dener with respect to Lichens, that this great section of the vegetable kingdom, which we had thought to be as well defined as mosses or Hepaticæ, is constituted of nothing else but low forms of Algœ, overrun by ascomycetous fungi, which have become parastic upon them. The principal support of his theory is founded on the similarity in structure between the gonidia of lichens and many unicellular Algœ, and under cultivation it was found that the gonidia of *Evernia* and *Cladonia* continued to propagate and also to produce zoospores. I do not know what our Crombie and Leighton have to say on the matter, but Nylander and Krempelhuber the great continental lichenologists, it is hardly necessary to say, are opposed to it, and no doubt continued observation of the plants throughout all their stages of development, will in time clear up the difficulty.

In Zoology I must give the highest place to the great work "Die Kalkschwämme," or Calcareous Sponges, of Ernst Haeckel, in which he gives due recognition to the merits of our English naturalists, Grant, Johnston and Bowerbank.

Grant first arranged the sponges into three divisions—Ceratospongiæ, Silicispongiæ, and Calcispongiæ; but while retaining the last, with which alone the present work deals, the author classes the two former together as Fibrospongiæ, and adds a third division, Myxospongiæ, for certain gelatinous forms, as *Halisarca*.

In the first volume of 484 pages are detailed the morphology of the Entoderm and Exoderm, the Syncytine or Sarcodous tissue, and the Spicules; the latter have a simpler nomenclature than that used by Dr. Bowerbank, being arranged in three groups:—1. Three-rayed; 2. Four-rayed (each with three divisions—regular, sagittal and irregular); and 3. Rod-like, which again embraces bacillose, fusiform and subuliform as single-poled, and clavate, rhopalate, stiliform, hastiform and perforate as double-poled forms; then

follows an account of the canal-systems and skeleton-systems, reproduction, distribution and position in the Animal Kingdom, this being not with the Protozoa but with the much higher Cœlenterata.

The second volume comprises the arrangement, which very curiously is on two systems, a natural and an artificial, each with different sets of genera, but which we are to adopt in naming the animals is not apparent.

The third volume is occupied by fifty-five superb plates and their descriptions, and the work must be universally regarded as one of the finest contributions to our knowledge of this group that has yet appeared.

I would also point out as worth your study, Dr. Pettigrew's "Lectures on the Physiology of the Circulation in Plants, the Lower Animals and in Man," in which he clearly shows that the forces engaged are the same throughout, and corresponding to certain physical forces existing in the inorganic world; that living plants and animals, and their circulating fluids, exhibit an infinite variety of movements in their healthy state, and that they take in and give out fluid and solid organic and inorganic matters according to fixed laws. Hence plants and animals control their movements irrespective of the substances by which they are surrounded, the vital forces working in harmony with the physical.

I offer these remarks on a few of the prominent objects borne towards us on that great ocean of truth, by whose shores we are daily wandering, but hundreds more float around them, which you may make your own, nay must, if you would not rest content

> In dropping buckets into empty wells,
> And growing old in drawing nothing up.

I would, in conclusion, remind you of that ancient gentle-

man, who with his gardener paid a visit for the first time in his life to his garden, and coming to a bed of tulips, says, "What are these?" "Tulips, sir." "Will they boil?" "No, sir." "Throw them out," and so on with other things. Anon they came to a holly-tree, which was condemned in like manner, but the gardener pointed out a little robin singing on the topmost bough, and begged that for its sake the tree should be spared; the tree was left for as long as the robin should frequent it, and you know it remains standing to this day.

Now our studies here may be but a holly-bush, yet if we cultivate them diligently, we shall find that a little robin presides over every one, and so long as he sings merrily in the green boughs, we must be made wiser, better, happier; and an influence for good be shed abroad in our hearts, not only for the remainder of this short life, but even for ever—and for ever.

QUEKETT MICROSCOPICAL CLUB, JUNE 30TH, 1873.

TREASURER'S STATEMENT OF ACCOUNT.

RECEIPTS.	£	s.	d.	PAYMENTS.	£	s.	d.
1872—July 1.				June 30.			
By Balance in hand	12	7	2	By Printing and Stationery	29	4	6
,, Deposit at City Bank withdrawn	10	0	0	,, Postage	4	4	10
,, Life Subscription brought forward	10	0	0	,, Attendance	8	0	6
,, Interest on Deposit	0	5	5	,, Books, &c.	6	1	0
,, New Life Member	10	0	0	,, Petty Expenses	9	16	3
,, Donation from Mr. Henry Horncastle	3	0	0	,, Advertisements	0	12	0
,, Subscriptions	233	10	0	,, On Account of Journal	29	13	0
,, Sales of Journal and Catalogues	3	3	6	,, Soirée	65	14	7
				,, Purchase of £21 : 18 : 4 New 3 per cent. Annuities	20	0	0
				,, Composition to Invest	10	0	0
				,, Balance	98	19	5
	£282	6	1		£282	6	1

We, the undersigned, having examined the above statement of Income and Expenditure, and the Vouchers referring thereto, hereby certify that the said Account is correct.

W. T. SUFFOLK,
EDWARD PATTISON PETT, } *Auditors.*

HONORARY FOREIGN MEMBERS.

Date of Election.	
Oct. 25, 1867	Guiseppe de Notaris, *Professor of Botany, &c., &c.*, Genoa.
Jan. 24, 1868	Arthur Meade Edwards, M.D., 314 West Thirty-fourth-street, New York.
Mar. 19, 1869	Rev. E. C. Bolles (*Ex-President of the Portland Society of Natural History*), Brooklyn, New York.
July 26, 1872	S. O. Lindberg, M.D., Professor of Botany, University of Helsingfors, Finland.
July 26, 1872	Prof. Hamilton L. Smith, President of Hobart-College, Geneva, New York, U.S.A.
July 26, 1872	Dr. J. Woodward, Assist. Surgeon General, U.S.A. Washington.

LIST OF MEMBERS.

Date of Election.	
Sept. 24, 1869	Ackland, William, L.S.A., F.R.M.S., 122 Newgate-street, E.C.
April 22, 1870	Adams, William, F.R.C.S., 37 Harrington-square, N.W.
Nov. 27, 1868	Adkins, William, 270 Oxford-street, W.
Oct. 27, 1865	Aldous, W. Lens, 47 Liverpool-street, W.C.
Mar. 23, 1866	Allbon, W., F.R.M.S., 525 New Oxford-street, W.C.
Oct. 28, 1870	Allen, Rev. Francis H., Ditchingham, Bungay, Norfolk.
Sept. 27, 1867	Allen, John T., 57 Cross-street, Islington, N.
July 23, 1869	Allen, W. H., C.E., 2 Abingdon Villas, Kensington, W.
July 26, 1872	Alstone, John, 140 Rye-lane, Peckham, S.E.
Dec. 17, 1869	Ames, George Acland, F.R.M.S., Union Club, Trafalgar-square, S.W.
Sept. 25, 1868	Andrew, Arthur R., 3 Neville-terrace, Fulham-road, S.W.
Dec. 22, 1865	Andrew, F.W., 3 Neville-terrace, Fulham-rd., S.W.
Oct. 25, 1872	Andrew, F. W., jun., 3 Neville-terrace, Fulham-road, S.W.
Sept. 22, 1865	Annett, James, Hampton, S.W.
July 7, 1856	Archer, J. A., 172 Strand, W.C.
Dec. 18, 1868	Ashby, John, Staines.
Feb. 23, 1872	Atkins, A., M.R.C.S., 232, Mile End-road, E.
Feb. 23, 1872	Atkins, A., jun., L.R.C.P., 232, Mile End-road, E.
Dec. 22, 1865	Atkinson, John, 54 Brook-street, W.
Feb. 26, 1869	Atkinson, William, F.L.S., 47 Gordon-square, W.C.
Mar. 27, 1868	Aubert, Alfred, Lloyds, E.C.
Nov. 25, 1870	Baber, Edward Cresswell, M.D., F.R.M.S., 34 Thurloe-square, S.W.

Date of Election.	
July 25, 1873	Baguley, John E., 51 Thistle-road, Brompton, S.W.
May 22, 1868	Bailey, Capt. L. C., R.N., F.R.G.S., R.A.S., Topographical Dept., New-st., Spring-gardens, S.W.
Dec. 27, 1867	Bailey, John W., 75 Broke-road, Dalston, E.
April 24, 1868	Baker, Charles, F.R.M.S., 244 High Holborn, W.C.
Feb. 28, 1873	Baker, Geo. H., M.R.C.S., 14 Mare-st., Hackney, E.
May 26, 1871	Balshaw, Rev. Robert, 55 Bessborough Gardens, S.W.
Mar. 24, 1871	Baly, Charles, 75 Margaret-street, W.
Dec. 27, 1872	Barnard, Herbert, 33 Portland-place, W.
Nov. 23, 1866	Barnes, Capt. E., Bridlington Quay.
Nov. 25, 1870	Barnes, Herbert J., 2 Richmond-villas, Union-rd., Highbury, N.
April 22, 1870	Barnes, Charles Barritt, 66 Old Broad-street, E.C.
Feb. 28, 1873	Barnett, F. C., 115 Upper-street, Islington, N.
Sept. 27, 1872	Bartlett, Edward, jun., 38 Connaught-square, W.
June 23, 1871	Bartlett, Wm. P., 2A Eastbourne-terrace, W.
Oct. 27, 1865	Barratt, T. J., 91 Great Russell-street, W.C.
June 24, 1870	BEALE, LIONEL S., M.B., F.R.S., F.R.M.S., 61 Grosvenor-street, W.
June 25, 1869	Beale, Charles J., Box 110, Post Office, Toronto, Canada.
Dec. 27, 1867	Bealey, Adam, M.D., Oak Lea, Harrogate.
May 28, 1869	Bean, Charles E., Brooklyn-house, Goldhawk-road, Shepherd's Bush, W.
Oct. 26, 1866	Beck, Joseph, F.R.M.S., 31 Cornhill, E.C.
May 26, 1871	Bedwell, Fras. Alfred, M.A., Cantab., F.R.M.S., 3 Old-square, Lincoln's-inn, W.C.
Aug. 23, 1867	Bell, James, F.R.M.S., The Laboratory, Somerset-house, W.C.
May 24, 1872	Bennett, W. H., St. George's Hospital, S.W.
Mar. 24, 1871	Bentley, Algernon Royds, 9 Portland-place, W.
Dec. 27, 1867	Bentley, C. S., Hazelville Villa, Sunnyside-road, Hornsey-rise, N.
May 22, 1868	Berney, John, F.R.M.S., 61 North-end, Croydon.
Oct. 23, 1868	Bevington, W. A., F.R.M.S., 113 Grange-road, S.E.

Date of Election.	
Mar. 27, 1868	Bidlake, J. P., B.A., F.C.P., F.C.S., F.R.M.S., 318, Essex-road, N.
June 24, 1870	Birch, A. E., 47 Halliford-street, Islington, N.
July 28, 1871	Bishop, Wm., 1 Alma-villas, Wood-green, N.
Feb. 23, 1866	Blake, T., 6 Charlotte-terrace, Brook-green, Hammersmith, W.
Mar. 19, 1869	Blankley, Frederick, F.R.M.S., 23 Belitha-villas, Barnsbury, N.
June 25, 1869	Bond, George, 11 St. Thomas'-place, Hackney, N.E.
Sept. 27, 1872	Borthwick, Rt. Hon. Lord, 35 Hertford-street, May-fair, W.
April 22, 1870	Bossy, Alfred Horsley, Prospect Cottages, Stoke Newington, N.
Nov. 27, 1868	Boustead, James, Stourfield Lodge, Effra-road, Brixton, S.E.
Mar. 27, 1868	Bowing, John, 6 Bowater-crescent, Woolwich, S.E.
July 23, 1869	Boyer, Richard, 20 Park-terrace, Highbury N.
Oct. 23, 1868	Brabham, T., 61 Castle-st., Leicester-square, W.C.
Dec. 22, 1865	Brain, T., 1 Upper Vernon-street, Lloyd-sq., W.C.
Oct. 27, 1865	BRAITHWAITE, R., M.D., M.R.C.S.E., F.L.S., F.R.M.S. (*President*), The Ferns, Clapham-rise, S.W.
Mar. 28, 1873	Bridgman, Frank G., 18 Queen Anne-street, Cavendish-square, W.
Dec. 27, 1872	Bridgman, Wm. Kencely, 69 St. Giles's-street, Norwich.
June 26, 1868	Briggs, H. B., 36½ Upper Thames-street, E.C.
May 27, 1870	Brigham, H. G., St. George's Hospital, S.W.
Mar. 22, 1867	Brightween, G., 8 Finch-lane, E.C.
Jan. 22, 1869	Brookes, William, 380, Camden-road, Holloway, N.
May 27, 1870	Brown, George Dransfield, M.R.C.S., Uxbridge-road, Ealing, W.
Dec. 28, 1866	Brown, W., 203 Great Portland-street, W.
May 22, 1868	Brown, W. J., 4 Malbro-terrace, Maple-road, Penge.
May 26, 1871	Browne George, 80 Pratt Street, Camden-town, N.W.
Feb. 27, 1872	Browne, Rev. Thomas Henry, F.R.M.S., High Wycombe, Bucks.

Date of Election.	
May 24, 1867	Browne, H., 40 Camden-square, N.W.
May 25, 1866	Buchanan, A., 382, Camden-road, N.
Sept. 27, 1872	Bugby, Wm., 3 Wilton-villas, Uxbridge-road, W.
Jan. 28, 1870	Bull, William J., M.A., Harrow.
May 24, 1872	Burch, Geo. J., Flint Cottages, Cheshunt, Herts.
Sept. 28, 1866	Burgess, J. W., 329 Hackney-road, N.E.
Feb. 23, 1866	Burgess, N., 329 Hackney-road, N.E.
June 25, 1869	Burgess, W. F., Guy's Hospital, S.E.
Aug. 26, 1870	Burgess, Martin, 10 Ashby-place, Brockley-road, S.E.
April 24, 1868	Burr, T. W., F.R.A.S., F.C.S., F.R.M.S. (*Vice-President*), 15 Tibberton-square, N.
Sept. 27, 1872	Bush, Wm., The Grove, East Dulwich, S.E.
June 14, 1865	Bywater, Witham, M., F.R.M.S., 5 Hanover-Square, W.
July 27, 1866	Bywater, W. M., jun., 5 Hanover-square, W.
May 24, 1867	Callaghan, James, 278 Commercial-road, Peckham, S.E.
Sept. 25, 1868	Capel, Charles C., North Cray-place, Chislehurst, Kent.
May 26, 1871	Catchpole, Robert, 101 Lancaster-road, Notting-hill, W.
Feb. 28, 1873	Chapman, A. W., 4 St. Augustine's-road, Camden-Town, N.W.
Dec. 27, 1867	Chapman, W. C., 39 Granville-square, W.C.
Nov. 26, 1869	Chater, E. M., Watford, Herts.
Sept. 23, 1870	Cheverton, George, High-street, Tunbridge Wells.
May 26, 1871	Coales, Dr. R., 119 Gower-street, W.C.
May 22, 1868	Cocks, W. G., 18 Kent-villas, Grange-road east, Dalston, N.E.
May 28, 1869	Cole, Walter B., F.R.M.S., St. John's-terrace, Weymouth.
May 23, 1873	Coles, Alfred, Stamford-hill, N.
Jan. 25, 1867	Coles, Ferdinand, A.P.S., 248 King's-road, Chelsea, S.W.
Feb. 23, 1872	Colvin, Alexander, Barham Lodge, Weybridge, Surrey.
April 23, 1869	Collings, Thomas P., 38 Surrey-street, Strand, W.C.

Date of Election.	
July 7, 1865	Collins, C., F.R.M.S., 157 Great Portland-st., W.
Sept. 27, 1872	Connolly, Chas. T., L.S.A., 3 Church-hill-villas, Wood-green, N.
Sept. 23, 1870	Connor, Rochfort, 9 St. Martin's-road, Stockwell, S.W.
Mar. 19, 1869	Cooke, Geo. E., Mead-villa, Willesden.
June 14, 1865	Cooke, M. C. (*Sect. for Foreign Correspondence*), 2 Grosvenor-villas, Junction-rd, Upper Holloway, N.
Feb. 22, 1867	Cooper, Frank W., L.R.C.S. Edin., Leytonstone, N.E.
Mar. 23, 1869	Coppock, C., F.M.S., F.R.M.S., 31 Cornhill, E.C.
Dec. 17, 1869	Coppock, Jones Henry, Bridport, Dorset.
June 27, 1873	Corbett, Alfred L., 103 Fentiman-road, Clapham, S.W.
May 28, 1869	Cottam, Arthur, F.R.A.S., Office of Woods, White-hall, S.W.
Aug. 28, 1868	Cousens, John, Grove-road, Wanstead, N.E.
July 26, 1872	Cowan, Thos. Wm., Hawthorn-house, Horsham, Sussex.
July 23, 1869	Creer, Edwin A. O., 2 Albany-place, Commercial-road East, E.
Aug. 28, 1868	Crisp, Frank, L.L.B., B.A. Lond., F.R.M.S., 134 Adelaide-road, N.W.
Dec. 23, 1870	Crisp, John S., 62 Camberwell-road, S.E.
Feb. 27, 1868	Crook, Thomas, F.R.M.S., 3 Grosvenor-villas, Cleveland-rd., Surbiton, S.W.
Oct. 26, 1866	Crookes, Wm., F.R.S., 20 Mornington-road, N.W.
July 7, 1865	Crosbie, J. J., The Chesnuts, Lyonsdown-road, New Barnet.
Sept. 28, 1866	Crouch, Henry, F.R.M.S., 66 Barbican, E.C.
Mar. 27, 1868	Cubitt, Charles, F.R.M.S., Woolwich-road, Bexley-heath.
May 25, 1866	Curties, T., F.R.M.S., 244 High Holborn, W.C.
April 26, 1872	Curwen, Herbert, Workington-house, Upton, Essex.
June 25, 1868	Darnley, D. Rowland, 12 John-street, Bedford-row, W.C.
June 23, 1871	D'Aubney, Thos., Shepherdess-walk, Hoxton, N.

Date of Election.	
Mar. 22, 1872	Daintrey, George, 43 Oakley-road, Southgate-road, W.
May 23, 1873	Davey, Robert R. F., War-office, Pall-mall, S.W.
Oct. 22, 1869	Davis, Henry, 19 Warwick-street, Leamington.
April 27, 1866	Davis, S., 11 Priory-road, South Lambeth, S.W.
Dec. 23, 1870	Dawson, George M., Royal School of Mines, S.W.
Jan. 22, 1869	Deed, Alfred, 94 King Henry's-road, Primrose-hill, N.W.
Nov. 27, 1868	Delferier, William, F.R.M.S., 40 Sloane-square, S.W.
Feb. 27, 1868	Dempsey, Joseph M., M.D., F.R.M.S., 27 Charter-house-square, E.C.
Jan. 26, 1872	Denyer, Edwin, High-street, Windsor.
July 23, 1869	Devenish, Samuel, 2 Champion-grove, Denmark-hill, S.E.
June 26, 1868	Dickens, Charles, Latimer-house, Hadley, Middlesex.
Feb. 25, 1870	Diss, William Jas., 17 Spurstowe-road, Amherst-road, Hackney, N.E.
Dec. 22, 1865	Dix, James, 26 Pentonville-road, N.
Nov. 24, 1865	Dobson, H. H., F.R.M.S., Pelham-lodge, Alexandra-road, St. John's-wood, N.W.
Jan. 25, 1867	Dodd, Josiah E., 11 Margaret-street, Cavendish-square, W.
July 26, 1872	Doggett, Ernest, 3 Liquorpond-street, W.C.
Aug. 28, 1868	Donaldson, Alexander L., 14 Wigmore-street, W.
Nov. 27, 1868	Douglas, Rev. R. C., Manaton Rectory, Moreton-hampstead, Exeter.
Jan. 28, 1870	Dowson, Edward, M.D., F.R.M.S., 117 Park-st., Grosvenor-square, W.
Dec. 27, 1867	Draper, E. T., F.R.M.S., 12 Buckingham-street, Strand, W.C.
July 28, 1871	Drew, G. C., Milton-house, Cassland-road, South Hackney.
Dec. 23, 1870	Duck, William A., 4 High-street, Vauxhall-cross, S.E.
April 26, 1872	Dudgeon, R. E., M.D., 53 Montagu-square, W.
Oct. 25, 1872	Dunning, Chas. G., 53 Crowndale-road, Camden-town, N.W.

Date of Election.	
Sept. 22, 1865	DURHAM, ARTHUR E., F.L.S., F.R.M.S., 82 Brook-street, Grosvenor-square, W.
Nov. 23, 1866	Durham, F., M.B., F.R.C.S., 14 St. Thomas's-street, S.E.
Aug. 26, 1868	Duer, Y., Cleygate, near Esher, Surrey.
Sept. 25, 1868	Eddy, James Ray, F.R.M.S., F.G.S., Carleton-grange, Skipton, Yorkshire.
June 28, 1867	Edmonds, R., 178 Burrage-rd., Plumstead, S.E.
July 27, 1865	Emery, J. J., 99 St. George's-road, Southwark, S.E.
May 26, 1871	Enock, Frederick, 48 Tollington-rd., Holloway, N.
Sept. 24, 1869	Epps, Richard, M.R.C.S., 89 Great Russell-street, Bloomsbury, W.C.
Dec. 18, 1868	Eyre, Samuel, Belmore-lodge, Priory-grove, South Lambeth, S.W.
July 25, 1873	Fase, Rev. Henry J., 57 Winchester-street, Pimlico, S.W.
Nov. 23, 1866	Fawn, George, 19 Alexandra-road, St. John's-wood, N.W.
Mar. 27, 1868	Field, James, High-street, Highgate, N.
July 26, 1867	Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh-house, Highbury New-park, N.
May 22, 1868	Ford, W. B., Claremont-cottage, Colney-hatch-road, Wood-green.
Jan. 27, 1871	Forshaw, Thomas, jun., the Bower, Bowden, Altrincham, Cheshire.
Aug. 4, 1865	FOSTER, PETER LE NEVE, M.A., Cantab., F.R.M.S., Society of Arts, Adelphi, W.C.
Mar. 24, 1871	Foulerton, Dr. J., Thatched House Club, Saint James's-street, S.W.
Oct. 22, 1869	Fox, Charles James, M.R.C.S., 27 Mortimer-street, W.
Dec. 28, 1866	Fox, C. J., F.R.M.S., 16 Cork-street, Bond-street, W.
July 26, 1872	Francis, T. Harper, 335 Gray's-inn-road, W.C.
June 23, 1871	Freeman, Henry E., 1 Rose-villas, Colney-hatch-road, Wood-green, N.

Date of Election.	
May 26, 1871	Freshwater, Thos. E., 2 Charlotte-street, Caledonian-road, N.
Feb. 26, 1869	Fricker, C. J., 4 Westow-hill-terrace, Upper Norwood, S.E.
May 22, 1868	Fryer, G. Henry, F.R.M.S., 14 The Terrace, Kilburn, N.W.
Oct. 26, 1868	Furlonge, W. H., Coed Mawr-house, Holywell, Flintshire.
July 28, 1871	Furneaux, John Richard, Boxgrove-house, Mayow-park, Forest-hill, S.
Nov. 25, 1870	Fyfe, Andrew, M.D., 42 Montpelier-square, S.W.
Mar. 19, 1869	Gann, James W., 171 Fenchurch-street, E.C.
Mar. 25, 1870	Garden, Robert Spring, 42 Carlton-hill, St. John's-wood, N.W.
May 25, 1866	Gardiner, G., 244 High Holborn, W.C.
April 24, 1868	Garnham, John, F.R.M.S., 123 Bunhill-row, E.C.
July 7, 1865	Gay, F. W., F.R.M.S., 113 High Holborn, W.C.
Sept. 22, 1865	Geddes, P., Millbank, Westminster, S.W.
Jan. 28, 1870	Gellatly, Peter, Loughton, Essex.
July 26, 1867	George, Edward, F.R.M.S., 12 Derby-villas, Forest-hill, S.E.
July 22, 1870	Gibson, Joseph F., F.R.M.S., 3 Furnival's-inn, E.C.
June 14, 1865	Gibson, W., 273 Regent-street, W.
June 27, 1873	Glasspoole, Hampden G., 2 Park-place, North-hill, Highgate, N.
Nov. 22, 1867	Golding, W. H., 19 Regina-road, Tollington-park, N.
Dec. 23, 1870	Goldsmith, John Charles, 5 America-square, E.C.
Oct. 26, 1866	Gooch, James W., 23 High-street, Eton.
Nov. 22, 1872	Goodchild, J. E., 114 Englefield-rd., Islington, N.
Aug. 23, 1872	Goode, A., Whitehall-lane, Woodford, Essex.
Dec. 22, 1865	Goode, W., 729 Wandsworth-road, S.W.
April 26, 1872	Goodinge, James Wallinger, 18 Aldersgate-street, E.C.
Feb. 25, 1870	Gray, Henry J., 27 Highgate-road, N.W.
Mar. 27, 1866	Gray, S. Octavus, 44 Doughty-street, W.C.
Dec. 22, 1865	Gray, W. J., M.D., F.R.M.S., 41 Queen Anne-street, Cavendish-square, W.

Date of Election.	
Jan. 28, 1870	Green, Nathaniel, E., 3 Circus-road, St. John's-wood, N.W.
Oct. 28, 1870	Greene, Wm. Asbury, Parkshot, Richmond, Surrey.
Oct. 23, 1868	Greenish, T., F.R.M.S., 20 New-street, Dorset-square, N.W.
Oct. 23, 1868	Gregory, Henry R., 10 Edith-grove, Fulham-road, S.W.
May 23, 1873	Gregory, William, 406 Strand, W.C.
May 25, 1866	Griffiths, A. W., 2 St. Mark's-road, Windsor.
July 24, 1868	Groves, J. W., F.R.M.S., 25 Charlotte-street, Bedford-square, W.C.
July 24, 1868	Grubbe, E. W., C.E., 49 Queen's-gardens, Hyde-park, W.
Jan. 27, 1871	Guimaraens, Augustus de Souza, F.R.M.S., 120 Ossulton-street, Euston-square, N.W.
Mar. 22, 1872	Guyton, Joseph, 5 Apsley-terrace, Acton, W.
Feb. 28, 1873	Haddon, Alfred C., 3 Bouverie-street, E.C.
June 14, 1865	Hailes, Henry F., 7 Harringay-road, Hornsey, N.
Aug. 26, 1870	Hailstone, Robert H., 35 Walworth-road, S.E.
Aug. 23, 1867	Hainworth, John, 138 Camden-road, N.W.
Feb. 23, 1867	Hainworth, W., Jun., Clare-villa, Cricketfield-rd., Lower Clapton.
Mar. 19, 1869	Hall, Marshall, Captn., F.G.S., F.C.S., F.R.M.S., New University Club, St. James's-street, S.W.
Dec. 28, 1866	Hallett, R. J., Hampton-house, Kilburn, N.W.
Oct. 26, 1866	Halley, Alexander, M.D., 7 Harley-street, W.
Feb. 22, 1869	Hammond, A., 3 Alexander-road, Marine-town, Sheerness.
Oct. 22, 1869	Harcourt, Cyril B., St. George's Hospital, S.W.
June 14, 1865	Hardwicke, Robert, F.L.S. *(Treasurer)*, 192 Piccadilly, W.
Sept. 28, 1866	Harkness, W., F.R.M.S., Laboratory, Somerset-house, W.C.
June 23, 1871	Harris, Edward, F.R.M.S., Rydal-villa, Langton-grove, Upper Sydenham, S.E.
May 22, 1868	Harris, W. H., F.C.S., Bombay.
July 26, 1872	Harrod, John, 3 Great Tower-street, E.C.
Nov. 26, 1869	Hart, Edward, Highbury New-park.

Date of Election.	
Aug. 24, 1866	HART, ERNEST, 42 Harley-street, W.
Oct. 26, 1866	Hart, G. W., Letterfrack, Co. Galway, Ireland.
Nov. 24, 1871	Hawker, Charles, M.D., 2 Albion-terrace, White Horse-lane, Stepney, E.
June 28, 1867	Hawksley, Thos. P., 4 Blenheim-street, New Bond-street, W.
June 24, 1870	Hawkins, Samuel J., Bleak Dean, near Heptonstall, Manchester.
May 27, 1870	Haywood, Henry, Dartmouth-terrace, Rotherhithe, S.E.
Aug. 28, 1868	Heawood, Francis R. H., 80 Mark-lane, E.C.
Jan. 25, 1867	Heisch, Charles, F.R.M.S., South-villa, Hampstead-heath, N.W.
Aug. 23, 1872	Hembry, B., 1 St. John's-villa, Overton-road, Brixton, S.W.
Aug. 26, 1870	Hennell, Col. S., F.R.M.S., Ventnor-villa, Ventnor, Isle of Wight.
June 26, 1868	Henry, A. H., 49 Queen's-garden, Hyde-park, W.
May 22, 1868	Hicks, J. J., 8 Hatton-garden, E.C.
Nov. 24, 1868	Hide, T. C., 46 Fenchurch-street, E.C.
Dec. 17, 1869	Hill, D. W., 78 Highbury New-park, N.
May 22, 1868	Hill, W. T., 4 Trinidad-place, Liverpool-road, N.
Sept. 24, 1869	Hilton, J. D., M.D., Upper Deal, Deal, Kent.
Sept. 28, 1866	Hind, F. H. P., Bartholomew-house, Bartholomew-lane, E.C.
May 26, 1871	Hinton, Chas. Howard, 18 Savile-row, W.
May 24, 1872	Hinton, Ernest, 42 Grafton-street, Seven Sisters-road, Holloway, N.
Aug. 26, 1870	Hirst, John, Jun., F.R.M.S., Dobcross, near Manchester.
Aug. 4, 1865	Hislop, W., F.R.A.S., 177 St. John-street-road, Clerkenwell, E.C.
Dec. 23, 1870	Histed, Edward, 27 Haymarket, S.W.
Oct. 26, 1866	Holdernesse, W. B., 12 Park-street, Windsor.
May 22, 1868	Holdsworth, Joseph, 33 Upper-street, Islington, N.
July 24, 1868	Holmes, W., M.R.C.S., 1 Brighton-villas, Lower Norwood, S.E.
April 27, 1866	Holtzapffel, J., A.I.C.E., 5 Great Coram-st., W.C.
April 26, 1867	Hooton, C., 3 Horningston-villas, Junction-rd., N.

Date of Election.	
May 22, 1868	Hopkinson, J., F.R.M.S., 8 Lawn-road, Haverstock-hill, N.W.
May 27, 1870	Horn, T. W., 6 Clarence-road, Finsbury-park, N.
July 23, 1869	Horn, William E., 50 Bessborough-street, S.W.
Oct. 26, 1866	Horncastle, H., Whitemoor, near Ollerton, Notts.
June 25, 1869	Houghton, W., Walthamstow, Essex.
April 26, 1867	Hovendon, F., 93 City-road, E.C.
Jan. 26, 1872	Hudson, Robert, F.R.S., F.R.M.S., Clapham-common, S.W.
Feb. 25, 1870	Hudleston, W. H., J.P., F.G.S., 23 Cheyne-walk, S.W.
Oct. 23, 1868	Hughes, R. H., B.A., Jesus Coll., Camb., 6 The Terrace, Putney, S.W.
June 25, 1869	Humphreys, Henry, B.A., 9 Amhurst-road-west, N.E.
Dec. 28, 1866	Hunt, W. H. B., F.R.M.S., 23 Eversholt-street, Oakley-square, N.W.
Nov. 24, 1871	Hurdell, Charles, 9 North Audley-street, W.
July 25, 1873	Hurst, John Thomas, The War-office, Whitehall.
May 24, 1867	Hutchinson, F., M.D., 29 Woburn-place, Russell-square, W.C.
Nov. 25, 1870	Hutton, Rev. Wyndham M., Lezayre-vicarage, Ramsey, Isle of Man.
May 24, 1867	Ingpen, John E., F.R.M.S. *(Hon. Secretary)*, 7 The Hill, Putney, S.W.
June 23, 1871	Isaac, Thomas, Maldon, Essex.
Feb. 23, 1872	Izod, Theodore, Chas., 10 Grange-villas, Grange-road, Upper Clapton.
Dec. 17, 1869	Jackson, B. D., F.R.M.S., 2 Morland-villas, Gresham-road, Brixton, S.W.
July 24, 1868	Jackson, F. R., Culver-cottage, Slindon, Arundel, Sussex.
June 14, 1865	Jaques, Edward, F.R.M.S., Woods and Forests Office, Whitehall, S.W.
June 26, 1868	Jeakes, Lt.-Colonel, Winchester-hall, Highgate, N.
Jan. 27, 1871	Jefferson, Henry, Eldon-house, Clapham-common.
April 23, 1869	Jefferson, Thomas, 3 Church-street, Lower Edmonton.

Date of Election.	
Feb. 28, 1873	Jenkins, J. W., 1 St. John's-hill, Wandsworth, S.W.
July 24, 1868	Jennings, Rev. Nathaniel, M.A., F.R.A.S., 66, Avenue-road, Regent's-park, N.W.
Jan. 24, 1868	Jewell, C. C., 2 Great Queen-street, W.C.
Oct. 28, 1870	Johnson, Arthur J., Weston, Toronto, Canada.
July 22, 1870	Johnson, F., Barnsbury-house School, Islington, N.
Jan. 25, 1867	Johnson, John A., 15 Wellington-road, Stoke Newington, N.
Feb. 24, 1871	Johnson, M. Hawkins, F.G.S., 379 Euston-road, N.W.
Jan. 26, 1866	Johnson, R. G., Horbury-villa, Ladbroke-square, Notting-hill, W.
Mar. 24, 1871	Johnstone, James, jun., 14 Lordship-park, Green-lanes, N.
Mar. 19, 1869	Jonas, L. E., 13 Canterbury-villas, Maida-vale, N.W.
Oct. 25, 1872	Jones, E. W., 53 Cowley-road, North Brixton, S.W.
Feb. 28, 1873	Jones, Geo. J., 73 High-street, Lymington, Hants.
Nov. 25, 1870	Jones, Lt.-Colonel Lewis, United Service Club, Pall-mall, S.W.
May 23, 1873	Jones, Captain Loftus F., United Service Club, Pall-mall, S.W.
Dec. 18, 1868	Jordan, James B., 11 Grafton-sq., Clapham, S.W.
May 23, 1873	Karop, Geo. C., 54 Patshull-road, Camden-town, N.W.
Oct. 26, 1866	Kemp, Robert, 25 Junction-rd., Upper Holloway, N.
May 23, 1873	Kennell, W. H., Hornton-cottage, Campden-hill, W.
Oct. 26, 1866	Kent, W. S., F.R.M.S., F.Z.S.
Aug. 23, 1867	Kiddle, Edward, The War Office, Pall-mall, S.W.
Mar. 19, 1869	Kilsby, Thomas W., Upper Fore-st., Edmonton, N.
July 7, 1865	King, G. H., 190 Great Portland-street, W.
July 22, 1870	King, Henry, 65 Myddelton-square, E.C.
Dec. 23, 1870	King, Robert, F.R.M.S., Fern-house, Upper Clapton, E.
April 26, 1867	Kirk, Joseph, 11 Blossom-street, Norton Folgate, N.E.

Date of Election.	
Feb. 28, 1873	Kitsell, Francis J., 7 John's-terrace, Latimer-road, W.
June 24, 1870	Knaggs, Henry G., M.D., 49 Kentish-town-road, N.W.
Oct. 23, 1868	Knevett, S., 18 Montague-street, Russell-square, W.C.
Mar. 28, 1873	Lacy, Brooke V., London-bridge, S.E.
Nov. 25, 1870	Ladd, Wm., F.R.A.S., F.R.M.S., 12 Beak-street, Regent-street, W.
July 27, 1866	Lambert, T. J., 151 Highbury New-park, N.
Nov. 23, 1866	Lambert, W., 4 New Basinghall-street, E.C.
Aug. 24, 1866	Lampray, John, F.R.G.S., F.A.S.L., F.R.M.S., 16 Camden-square, N.W.
Mar. 22, 1867	Lancaster, Thos., Bownham-house, Stroud, Gloucestershire.
Dec. 28, 1866	Langrish, H., 250 Pentonville-road, N.
Aug. 4, 1865	LANKESTER, EDWIN, M.D., F.R.S., F.L.S., F.R.M.S., Melton House, Child's-hill, Hampstead, N.W.
April 26, 1872	Law, Rev. William, Marston Trussell, Market Harborough.
June 25, 1869	Layton, Charles E., 8 Upper Hornsey-rise, N.
Dec. 22, 1871	Lea, Henry, 1 Horningsham-villas, Junction-road, Upper Holloway, N.
Aug. 28, 1868	Leaf, C. J., F.L.S., F.R.M.S., &c. (*President of the Old Change Microscopical Society*), Old Change, E.C.
Mar. 19, 1869	Lee, Henry, F.L.S., F.R.M.S., &c., The Waldrons, Croydon.
Oct. 25, 1867	Leifchild, J. R., M.A., 42 Fitzroy-street, Fitzroy-square, W.
Sept. 22, 1865	Leighton, W. H., 2 Merton-place, Chiswick, W.
June 25, 1869	Lemmon, Benj., 61 Hungerford-road, Islington, N.
July 25, 1873	Le Pelley, C., 27 Underwood-street, Shepherdess-walk, Hoxton, N.
May 28, 1869	Letts, Edmund A., South View, Black Gang, Isle of Wight.
July 26, 1872	Levien, Charles N., 3 Great Tower-street, E.C.

Date of Election.	
Mar. 22, 1867	Lewinsky, John, 13 Frith-street, Soho, W.
April 27, 1866	Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 1 Lowndes-terrace, Knightsbridge, S.W.
Nov. 24, 1871	Lewis, T. Preston, 8 The Crescent, Norwich.
June 26, 1868	Lindley, W., jun., Kidbrook-terrace, Blackheath, S.E.
Nov. 24, 1865	Loam, Michael, Hampton, Middlesex, S.W.
May 26, 1871	Locke, John, 65 Camden-st., Camden-town, N.W.
April 23, 1869	Long, Henry, 90 High-street, Croydon.
Nov. 24, 1865	Lovibond, J. W., F.R.M.S., St. Anne-street, Salisbury.
Sept. 22, 1865	Lovick, T., Board of Works, Spring-gardens, S.W.
May 28, 1869	Lowe, Henry W., Heathfield, Sydenham-hill, S.E.
Dec. 18, 1868	LOWNE, BENJAMIN THOMPSON, M.R.C.S., F.R.M.S. (*Vice-President*), 49 Colville-gardens, W.
April 27, 1866	Loy, W. T., F.R.M.S., 9 Garrick-chambers, Garrick-street, W.C.
Jan. 24, 1873	McBride, Francis J., 47 Windsor-terrace, City-road, E.C.
Jan. 24, 1868	Macdonald, J., M.D., 68 Up. Kennington-lane, S.E.
Nov. 25, 1870	McHardy, M. M., St. George's Hospital, S.W.
Nov. 23, 1866	McIntire, S. J., F.R.M.S., 22 Bessborough-gardens, S.W.
Jan. 26, 1872	McKechnie, J. Hamilton, M.D., 16 Princes-street, Cavendish-square.
May 22, 1868	McVean, W., 18 Wood-street, E.C.
Sept. 27, 1872	Manning, His Grace the Archbishop, Francis-st., Vauxhall Bridge-road, S.W.
June 14, 1865	Marks, E. (*Assistant-Secretary*), Laburnam-cottage, Middle-lane, E.C.
Mar. 22, 1872	Marquand, Ernest D., 2 Newport-villas, Finchley.
June 26, 1868	Martin James, 110 Regent-street, W.
Dec. 27, 1867	Martinelli, A., 106 Albany-street, N.W.
Oct. 25, 1867	Marwood, W. G. H., 68 Downham-road, Kingsland, N.
June 27, 1873	Mason, Thomas, 123 Newgate-street, E.C.
April 26, 1867	Matthews, G. K., St. John's-lodge, Beckenham, Kent, S.E.

Date of Election.	
May 28, 1869	Matthews, Henry, 60 Gower-street, W.C.
Oct. 26, 1866	MATTHEWS, JOHN, M.D., F.R.M.S. (*Vice-President*), 4 Mylne-street, Myddelton-square, E.C.
June 28, 1867	Matthews, Peter, L.D.S., F.Z.S., F.R.M.S., 11 Welbeck-street, W.
Sept. 24, 1869	Matthews, William, 374 Camden-road, N.
Aug. 27, 1869	Mavor, William Samuel, 91 Park-st., Grosvenor-square, W.
May 26, 1871	May, John William, F.R.M.S., Arundel-house, Percy-cross, Fulham, S.W.
Feb. 28, 1873	Mayhew, A. F., 12 Crescent-terrace, Pimlico, S.W.
Mar. 22, 1867	Meacher, John W., 10 Hillmarten-road, Camden-road, N.
May 27, 1870	Medlock, Henry, M.D., 22 Tavistock-square, W.C.
Dec. 18, 1868	Mestayer, Richard, F.L.S., F.R.M.S., 7 Buckland-crescent, Belsize-park, N.W.
May 28, 1869	Millar, John, M.D., F.L.S., F.G.S., F.R.M.S., &c., Bethnal-house, Cambridge-road, N.E.
June 26, 1868	Milledge, Alfred, 4 Upper Winchester-road, Stanstead-road, Forest-hill, S.E.
Sept. 28, 1866	Miller, Benj., F.R.M.S., 4 Denmark-hill, S.E.
July 7, 1865	Millett, F. W., 15 Alfred-street, River-terrace, N.
Feb. 28, 1873	Mills, Chas., 12 Courtney-rd., Highbury-park, N.
June 25, 1869	Moggridge, Matthew, F.G.S., care of Rev. M. W. Moggridge, Long Ditton, Kingston-on-Thames, Surrey.
May 25, 1866	Moginie, W., F.R.M.S., 14 Riding-house-street, W.
Mar. 27, 1868	Moore, Daniel, M.D., Hastings-lodge, Victoria-road, Upper Norwood, S.E.
Oct. 27, 1865	Morrieson, Colonel R., F.R.M.S., Oriental Club, Hanover-square, W.
July 26, 1867	Mott, H. H., 47 Union-grove, Clapham, S.W.
April 24, 1868	Mummery, J. Rigden, F.L.S., F.R.M.S., 10 Cavendish-place, W.
April 24, 1868	Mummery, J. Howard, 10 Cavendish-place, W.
Dec. 18, 1868	Mundie, George, M.R.C.S., 93 Richmond-road, Dalston, N.E.
Jan. 25, 1867	Murray, R. C., 69 Jermyn-street, St. James's, S.W.

Date of Election.	
Sept. 27, 1867	Nash, Thompson, 14 Douglas-road, Canonbury-square, N.
Mar. 23, 1866	Nation, W. J., 30 King-square, Goswell-road, E.C.
Mar. 24, 1871	Nelson, James, 2 Durham-place, Lambeth-road, S.E.
Jan. 26, 1872	Newton, Edwin Tulley, Geological Museum, Jermyn-street, S.W.
July 26, 1872	Nicoll, Geo., jun., 4 Kingston-villas, Buckhurst-hill, Essex.
July 7, 1865	Nicholson, D., 51 St. Paul's-churchyard. E.C.
May 26, 1871	Oriel, Chas. F., Oak-villa, Mattock-lane, Ealing, W.
Dec. 27, 1867	Osborn, C. E., 28 Albert-road, St. John's-ville, Highgate, N.
Dec. 27, 1867	Oxley, F., 8 Crosby-square, Bishopsgate, E.C.
Nov. 27, 1868	Parker, T., 10 Brunswick-square, Camberwell, S.E.
Dec. 17, 1869	Parker, William, M.D., 133 Grange-road, Bermondsey, S.E.
Oct. 27, 1871	Parsons, Fred. Anthony, 18 London-street, City, E.C.
June 25, 1869	Pass, H., 11 Spring-terrace, Wandsworth-road, S.W.
May 26, 1871	Paxton, Rev. W. Archibald, M.A., Otterden Rectory, Faversham, Kent.
May 24, 1867	Pearce, G. T., 39 Clapham-road, S.W.
Feb. 23, 1872	Pearse, W. E. Grindley, L.R.C.P., 24 Bessborough-gardens, South Belgravia, S.W.
May 24, 1867	Pearson, John, 212 Edgware-road, W.
May 28, 1869	Pepler, W. B., Market Lavington, Wilts.
Oct. 25, 1867	Peppin, S. H., 25 Princes-st., Leicester-square, W.
Nov. 26, 1869	Perken, Edmund, 24 Hatton-garden, E.C.
July 23, 1869	Perry, F. J., 148 Church-road, Islington, N.
May 26, 1871	Pett, Edward Pattison, Romney-villa, Elfra-road, Tulse-hill, S.W.
Oct. 27, 1865	Pickard, J. F., 1 Bloomsbury-street, W.C.
Dec. 23, 1870	Piggott, G. W. Royston, B.A., M.D., F.R.M.S., &c., 2 Lansdown-crescent, Kensington-park, W.
Mar. 22, 1872	Pinker, R. H., Regency-square, Brighton.

Date of Election.	
Jan. 22, 1869	Pillischer, M., F.R.M.S., 88 New Bond-street, W.
Nov. 24. 1871	Pitts, Fred., Harvard-house, St. John's-hill, Clapham.
June 25, 1869	Pocock, Lewis, jun., 70 Gower-street, W.C.
July 23, 1866	Pocock, Thos. Willmer, 10 Ampthill-square, N.W.
Nov. 23, 1866	Potter, G., F.R.M.S., 42 Grove-road, Upper Holloway, N.
June 22, 1866	Powe, I., St. John's, Richmond, Surrey.
May 25, 1866	Powell, Hugh, F.R.M.S., 170 Euston-road, N.W.
Jan. 24, 1873	Powell, Jas. J., 43 Burton-road, Brixton, S.W.
July 7, 1865	Powell, Thomas, 18 Doughty-street, Mecklenberg-square, W.C.
Oct. 26, 1866	Praill, Edward, 39 Mornington-road, N.W.
Dec. 27, 1867	Preston, H. B., 1 Devonshire-road, Liverpool.
June 24, 1870	Preston, Francis W. H., 30 Warwick-gardens, Kensington, W.
Jan. 26, 1872	Price, F. G. Hilton, Temple-bar, E.C.
Oct. 25, 1872	Price, W. H., 1 The Terrace, Kennington-park, S.E.
Feb. 26, 1869	Prichard, Thomas, M.D., Abbington Abbey, Northampton.
June 27, 1873	Priest, B. W., 22 Parliament-street, S.W.
Nov. 27, 1868	Pritchett, Benjamin, 131 Fenchurch-street, E.C.
July 26, 1867	Pritchett, Francis, 131 Fenchurch-street, E.C.
April 23, 1869	Quekett, Arthur Edwin, 13 Delamere-crescent, Westbourne-square, W.
April 23, 1869	Quekett, Alfred J. S., 13 Delamere-crescent, Westbourne-square, W.
April 23, 1869	Quekett, Rev. William, The Rectory, Warrington.
Feb. 23, 1866	Quick, George E., 109 Long-lane, Bermondsey, S.E.
Oct. 26, 1866	Rabbits, W. T., Selwood, Mayow-road, Forest-hill, S.E.
Nov. 23, 1866	Radermacher, J. J., 21 Tregunter-road, The Boltons, Brompton, S.W.
Sept. 24, 1869	Radcliffe, J. D., 93 Albion-road, Dalston.
Oct. 26, 1866	Ramsbotham, J. M., M.D., 15 Amwell-street, Pentonville, E.C.

Date of Election.	
Oct. 26, 1866	Ramsden, Hildebrand, M.A., F.L.S., F.R.M.S., Forest-rise, Walthamstow, N.E.
Aug. 28, 1868	Rance, T. G., Widmore-lane, Bromley, Kent.
May 22, 1868	Rawles, W., 64 Kentish-town-road, N.W.
Oct. 28, 1870	Rean, Walter, Woodstock-road, Poplar, E.
June 27, 1873	Reeve, Fredk., 37 Fentiman-rd., Clapham, S.W.
July 7, 1865	Reeves, W. W., F.R.M.S., 37 Blackheath-hill, Greenwich, S.E.
May 26, 1871	Richards, Edward, F.R.M.S., 289 Camberwell New-road, S.E.
Mar. 25, 1870	Richardson, Thomas Hyde, 1 Belgrave-villas, Holmesdale-road, Selhurst, S.E.
Jan. 24, 1868	Richardson, C. J., 44 Duncan-terrace, Islington, N.
Dec. 22, 1865	Richardson, C. T., M.D., 36 Dorset-square, N.W.
Feb. 23, 1866	Rixon, F., F.R.M.S., Loats-road, Clapham-park, S.W.
June 25, 1869	Roberts, John H., F.R.C.S., F.R.M.S., 20 New Finchley-road, St. John's-wood, N.W.
April 26, 1872	Roberts, S. Hackett, 355 Walworth-road, S.E.
May 22, 1868	Rogers, John, F.R.M.S., Elm-avenue, New Basford, near Nottingham.
Oct. 26, 1866	Rogers, Jos. R., 12 Bellefield-terrace, Bellefield-road, Stockwell, S.W.
Oct. 26, 1866	Rogers, Thomas, F.R.M.S., Mortlock-house, Loughborough-road, Brixton, S.W.
April 24, 1868	Rogerson, John, F.R.M.S., care of Mr. H. Crouch, 66 Barbican, E.C.
Mar. 22, 1872	Rolfe, Charles Spencer, care of H. Wyndham, Esq., 5 Westminster-chambers, S.W.
May 22, 1868	Roper, F. C. S., F.L.S., F.G.S., F.R.M.S., Palgrave-house, Eastbourne, Sussex.
July 24, 1868	Rowe, James, jun., M.R.C.V.S., 65 High-street, Marylebone, W.
Oct. 26, 1866	Rowlett, John, 10 Crozier-street, S.E.
June 14, 1865	Ruffle, G. W. *(Curator)*, 131 Blackfriars-road, S.E.
Oct. 27, 1865	Russell, James, 4 Lansdowne-terrace, London-fields, Hackney, N.E.
Oct. 26, 1866	Russell, Joseph, F.R.M.S., Cumberland-lodge, Brixton-hill, S.W.

Date of Election.	
May 22, 1868	Russell, Thomas D., 21 Park-road, West Dulwich, S.E.
Feb. 22, 1867	Rutter, H. Lee, 1 St. Barnabas-villas, Lansdowne-circus, South Lambeth, S.W.
May 23, 1873	Salkeld, Lt. Colonel Joseph C., F.R.C.S.,F.R.M.S., 29 St. James's-street, S.W.
Dec. 17, 1869	Salmon, John, 24 Seymour-street, Euston-square.
Dec. 17, 1869	Sanders, Gilbert, Brockley-on-the-Hill, Monkstown, Dublin.
July 28, 1871	Sansom, Arthur Ernest, M.D., 29 Duncan-terrace, Islington, N.
July 26, 1872	Sargent, J., jun., Fritchley, near Derby.
July 26, 1872	Sarll, John, De Beauvoir House, Englefield-rd., N.
May 22, 1867	Scatliff, John Parr, M.D., 132 Sloane-street, S.W.
May 24, 1872	Schloesser, Ernest, 9 College-hill, Cannon-st., E.C.
May 28, 1869	Scoble, Samuel W., Harrington-villa, Burnt-ash-lane, Lee, Kent.
May 24, 1872	Sequeira, H. L., M.R.C.S., 1 Jewry-street, Aldgate, E.C.
July 27, 1868	Sewell, Richard, Prince's-road, Lambeth, S.E.
July 27, 1866	Sharpey, W., M.D., F.R.S., 33 Woburn-place, W.C.
Oct. 22, 1869	Shaw, Wm. Forster, 50 Threadneedle-street, E.C.
Jan. 22, 1869	Sheehy, William H., M.D., 4 Claremont-square, N.
May 24, 1872	Sheehy, W. H. Podmore, 4 Claremont-square, N.
May 26, 1871	Sigsworth, J. C., F.R.M.S., 21 Clarendon-road, Holland-park, W.
June 27, 1873	Simmonds, Joseph E., 32 Cornwall-street, Fulham, S.W.
Aug. 23, 1867	Simmons, James J., L.D.S., F.R.M.S., 18 Burton-crescent, W.C.
May 28, 1869	Simonds, Professor J. B., F.R.M.S., Royal Veterinary College, N.W.
Dec. 28, 1866	Simpson, G. Wharton, 36 Canonbury-park South, N.
Mar. 27, 1868	Simson, Thos., The Laurels, Courtyard, Eltham.
May 28, 1869	Sketchley, H. G., 10 Ampthill-square, N.
Dec. 28, 1866	Slade, J., 100 Barnsbury-road, N.
Mar. 22, 1872	Smart, Harry, 11 Paragon-terrace, Hackney.

Date of Election.	
Oct. 23, 1868	Smart, William, 27 Aldgate, E.
May 25, 1866	Smith, Alpheus, (*Librarian*), 42 Choumert-road, Rye-lane, Peckham.
Mar. 25, 1870	Smith, Francis Lys, 3 Grecian-cottages, Crown-hill, Norwood.
June 27, 1873	Smith, G. J., 2 Foster-lane, Cheapside, E.C.
Oct. 26, 1868	Smith, H. Ambrose, 2 King William-st., City, E.C.
June 26, 1868	Smith, James, F.L.S., F.R.M.S., 407 Liverpool-road, Islington, N.
May 22, 1868	Smith, James John, F.R.M.S., 56 Tollington-road, N.
Dec. 23, 1870	Smith, Joseph A., London and County Bank, Newington, S.E.
April 23, 1869	Smith, Vernon, 37 Tavistock-square, W.C.
June 24, 1870	Smith, William, 1 Down-place, Hammersmith, W.
Feb. 28, 1873	Smith, W. Lepard, Southfield-house, Watford.
Aug. 23, 1872	Smith, W. S., 24 Holford-square, Pentonville.
April 24, 1868	Snellgrove, W., 22 Surrey-square, S.E.
Sept. 22, 1865	Southwell, C., 44 Princes-street, Soho, W.
Dec. 18, 1868	Sowerby, D., 38 Albert-road, Dalston, N.E.
May 22, 1868	Spencer, John, Brook's Bank, 81 Lombard-street, City, E.C.
Nov. 22, 1872	Spencer, Thomas, F.G.S., F.R.M.S., 32 Euston-square, N.W.
Nov. 23, 1866	Spurrell, F. C. J., F.R.M.S., Belvidere, Kent, S.E.
April 22, 1870	Stanley, William Ford, F.S.A., F.R.M.S., Railway-approach, London-bridge, S.E., and Stanleybury, Upper Norwood, S.E.
May 26, 1871	Stapleton, Henry, 55 Beresford-road, Highbury-new-park, N.
Mar. 24, 1865	Starling, Benjamin, 11 Gray's-inn-square, W.C.
Feb. 23, 1872	Stevens, C. R., 7 Ashby-road, Canonbury, N.
Aug. 24, 1866	Steward, J. H., F.R.M.S., 406 Strand, W.C.
May 23, 1873	Steward, James H. C., 406 Strand, W.C.
Mar. 19, 1869	Stokes, Frederick, Hepta-house, Stansfield-road, Stockwell, S.W.
Oct. 27, 1871	Stuart, David John, 39 Marquess-road, Canonbury, N.
July 7, 1865	Suffolk, W. T., F.R.M.S., Claremont-lodge, Park-street, Camberwell, S.E.

Date of Election.	
June 27, 1873	Suter, Edward, Kent-lodge, Douglass-road North, Canonbury, N.
Nov. 22, 1867	Swainston, J. T., 14 Loraine-place, Holloway, N.
Nov. 24, 1865	Swansborough, E., 20 John-street, Bedford-row, W.C.
June 24, 1870	Swain, Ernest, 89 Ladbroke-road, W.
Dec. 18, 1868	Swift, James, 43 University-street, W.C.
June 26, 1868	Syms, F. R., 4 Acacia-villas, Upper Richmond-road, Putney, S.W.
May 24, 1872	Symons, Henry E., M.D., F.R.M.S., St. Bartholomew's Hospital, E.C.
Nov. 25, 1870	Tafe, John Forwood, 34 Old Broad-street, City, E.C.
May 22, 1868	Tatem, J. G., Russell-street, Reading.
Aug. 25, 1871	Taverna, The Count Joseph, 25 Trafalgar-square, Brompton, S.W.
Dec. 22, 1865	Terry, J., 109 Borough-road, S.E.
Aug. 23, 1872	Terry, Thomas, 5 Austin-friars, E.C.
July 23, 1869	Thin, James, Ormiston-lodge, Claremont-place, Brixton-road, S.W.
Feb. 24, 1871	Thornthwaite, W. H., jun., 122 Newgate-st., E.C.
Jan. 24, 1868	Tomkins, Samuel Leith, 26, Buckland-crescent, Belsize-park, N.W.
June 23, 1871	Topping, Amos, 28 Charlotte-street, Caledonian-road, N.
July 26, 1872	Townsend, John Sumsion, F.R.M.S., 59, London-road, Croydon.
April 26, 1872	Tozer, Edward, Ivy-lodge, Woodford, Essex.
July 24, 1868	Tulk, John A., M.D., Spring-grove, Isleworth, W.
July 24, 1868	Tulk, John A., F.R.M.S., &c., Firfield, Addlestone, Weybridge.
July 26, 1867	Turnbull, Joseph, 1 Clifton-villas, Highgate-hill, N.
June 25, 1869	Turner, R. D., Chafford, Tunbridge.
Oct. 25, 1872	Vallence, P., Cobbs-court, Cootham, Pulborough, Hants.
July 27, 1866	Veitch, Harry, F.H.S., The Royal Exotic Nursery, King's-road, Chelsea, S.W.
Feb. 23, 1866	Walker, A., M.D., 17 Throgmorton-street, E.C.

Date of Election.	
May 28, 1869	Walker, Henry, 100 Fleet-street, E.C.
July 25, 1873	Walker, John Stringer, Warwick-road, Upper Clapton, E.
June 26, 1868	Walker, J. W., Fairfield-house, Watford.
Dec. 18, 1868	Waller, Arthur, F.R.M.S., 11 Aberdeen-park, Highbury, N.
May 22, 1868	Waller, J. G., 68 Bolsover-street, Portland-road, W.
Oct. 27, 1865	Wallis, George, South Kensington Museum, S.W.
Aug. 26, 1870	Warburton, Samuel, Merton villa, New-road, Lower Tooting, S.W.
Dec. 22, 1871	Ward, Daniel, 26 Coleman-street, Woolwich.
Nov. 22, 1867	Ward, F. H., M.R.C.S., Springfield-house, near Tooting, Surrey.
Dec. 18, 1868	Warner, Alfred, 6 South-terrace, Hatcham-park-road, New-cross, S.E.
Feb. 26, 1869	Warner, William, 51 Bookham-street, New North-road, N.
May 25, 1866	Warrington, H. R., 7 Royal Exchange, Cornhill, E.C.
Oct. 27, 1865	Watkins, C. A., 10 Greek-street, Soho, W.
Oct. 25, 1872	Watkins, J. L., L.R.C.P., Union-street, Deptford, S.E.
Sept. 22, 1865	Watson, T. G., 43 Poland-street, Oxford-street, W.
Sept. 25, 1868	Waugh, J. W. Spencer, 4 Maitland-park-villas, Haverstock-hill, N.W.
Dec. 28, 1866	Way, T. E., 65 Wigmore-street, W.
Jan. 22, 1869	Webb, George, 3 Crosby-square, Bishopsgate, E.C.
Dec. 22, 1871	Webber, John, Limes Villas, Croxted-road, Dulwich.
May 24, 1867	Weeks, A. W. G., 18 Gunter's-grove, Chelsea, S.W.
Dec. 28, 1866	Wheldon, W., F.R.M.S., 58 Great Queen-street, W.C.
Dec. 27, 1872	White, Charles E., 32 Belgrave-road, S.W.
April 23, 1869	WHITE, CHARLES FREDERICK, F.R.M.S. (*Vice-President*), 42 Windsor-road, Ealing.
Feb. 26, 1868	White, Francis W., 2 Brunswick-cottages, Gipsy-hill, S.E.
May 22, 1868	White, T. Charters, M.R.C.S., F.R.M.S., 32 Belgrave-road, S.W.
July 25, 1873	White, Walter, Litcham, Norfolk.

Date of Election.	
May 24, 1867	White, W., F.R.M.S., Cawston, Sandown, Isle of Wight, N.
May 23, 1873	Whitmore, John, M.D., 15 Wimpole-street, W.
July 24, 1868	Wight, James F., F.R.M.S., Gatcombe-villa, Croxted-road, West Dulwich, S.E.
May 22, 1868	Wigner, John M., B.A., B.Sc., 16 Grove-hill-terrace, Grove-lane, Camberwell, S.E.
Mar. 24, 1871	Williams, George, 6 St. John's-park, Upper Holloway, N.
Oct. 28, 1870	Williams, Martin G., 2 Highbury-crescent, N.
July 28, 1871	Williams, Robert Pakenham, 3 Whittington-grove, Highgate-hill, N.
Feb. 28, 1873	Williams, Wm. A. B., 23 Highbury-place, N.
Jan. 25, 1867	Willsworth, H., 7 Whittington-terrace, Upper Holloway, N.
Feb. 23, 1866	Wilshin, J., 12 Totford-place, Neckinger, Bermondsey, S.E.
Feb. 22, 1867	Wilson, Frank, 110, Long-acre, W.C.
April 24, 1868	Withall, Henry, 1 The Elms, St. John's-road, Brixton, S.W.
May 28, 1869	Wood, Charles H., F.C.S., 25 Devonshire-road, Holloway, N.
Aug. 27, 1869	Woods, W. Fell, 1 Park-hill, Forest-hill, S.E.
Oct. 25, 1867	Worthington, Richard, Champion-park, Denmark-hill, S.E.
June 27, 1873	Wrey, George E. B., Addington-house, Addington-road, Reading.
Nov. 23, 1866	Wright, Edward, 89 Shepherdess-walk, E.C.
Aug. 4, 1865	Wyatt, C. C., 9 North Audley-street, W.
Oct. 26, 1866	Yeats, Christopher, Mortlake, Surrey, S.W.
Sept. 23, 1870	Yeoman, L. C. B., 21 Gutter-lane, E.C.

NOTICE.

Members are reminded that the Subscriptions for the year commencing July 1st, 1873, and ending June 30th, 1874, are now due.

They are requested to send the amount by Cheque or Post Office Order (not Stamps) to the Treasurer, Mr. Robt. Hardwicke, 192, Piccadilly, W., where Subscriptions can be received any day between 10 and 4.

Any member of the Club changing his address, will oblige by communicating his new direction to the Secretary without delay.

RULES.

I.—That "The Quekett Microscopical Club" hold its meetings at University College, Gower Street, on the fourth Friday Evening in every month, at Eight o'clock precisely, or at such other time or place as the Committee may appoint.

II.—That the business of the Club be conducted by a Committee consisting of the President, four Vice-Presidents, the Treasurer, the Honorary Secretary, the Honorary Secretary for Foreign Correspondence, and twelve other members,—six to form a quorum. That the President, Vice-Presidents, Secretaries, and the four senior members of the Committee (by election) retire annually, but be eligible for re-election. That the Committee may appoint a stipendiary Assistant Secretary, who shall be subject to its direction.

III.—That at the ordinary Meeting in June, nominations be made of Candidates to fill the offices of Vice-Presidents and vacancies on the Committee. That such nominations be made by resolutions duly moved and seconded, no Member being entitled to propose more than one Candidate. That in the event of such nominations exceeding one half more than the number of vacant offices, the Candidates be reduced by show of hands to such proportion. That the President, Treasurer, Honorary Secretary, and Honorary Secretary for Foreign Correspondence be nominated by the Committee. That a list of all nominations made as above be printed in alphabetical order upon the ballot paper. That at the Annual General Meeting in July all the above officers be elected by ballot from the candidates named in the lists, but any member is at liberty to substitute on his ballot-paper any other name or names in lieu of those nominated for the offices of President, Treasurer, Honorary Secretary, and Honorary Secretary for Foreign Correspondence.

IV.—That in the absence of the President and Vice-Presidents the Members present at any ordinary Meeting of the Club elect a Chairman for that evening.

V.—That every Candidate for Membership be proposed by two or more Members, who shall sign a certificate (see Appendix) in recommendation of him—one of the proposers from personal knowledge. The certificate shall be read from the chair, and the Candidate therein recommended ballotted for at the following Meeting. Three black balls to exclude.

VI.— That the society include not more than twenty Foreign Honorary Members, elected by the Members by ballot upon the recommendation of the Committee.

VII.—That the Annual Subscription be Ten Shillings, payable in advance on the 1st of July, but that any Member elected in May or June be exempt from subscription until the following July. That any Member desirous of compounding for his future subscription may do so at any time by payment of the sum of Ten Pounds; all such sums to be duly invested in such manner as the Committee shall think fit. That no person be entitled to the full privileges of the Club until his subscription shall have been paid; and that any Member omitting to pay his subscription six months after the same shall have become due (two applications in writing having been made by the Treasurer) shall cease to be a Member of the Club.

VIII.—That the accounts of the Club be audited by two Members, to be appointed at the ordinary Meeting in June.

IX.—That the Annual General meeting be held on the fourth Friday in July, at which the Report of the Committee on the affairs of the Club, and the Balance Sheet duly signed by the Auditors shall be read. Printed lists of Members nominated for election as President, Vice-Presidents, Treasurer, Secretaries, and Members of the Committee having been distributed, and the Chairman having appointed two or more Members to act as Scrutineers, the Meeting shall then proceed to ballot. If from any cause these elections, or any of them, do not take place at this Meeting, they shall be made at the next ordinary Meeting, of the Club.

X.—That at the ordinary Meetings the following business be transacted:—The minutes of the last Meeting shall be read and confirmed; donations to the Club since the last Meeting announced

and exhibited; ballots for new Members taken; papers read and discussed; and certificates for new Members read; after which the Meeting shall resolve itself into a conversazione.

XI.—That any Member may introduce a Visitor at any ordinary meeting, who shall enter his name with that of the Member by whom he is introduced, in a book to be kept for the purpose.

XII.—That no alteration be made in these Laws, except at an Annual General Meeting, or a Special General Meeting called for that purpose; and that notice in writing of any proposed alteration be given to the Committee, and read at the ordinary Meeting at least a month previous to the Annual or Special Meeting, at which the subject of such alteration is to be considered.

APPENDIX.

Form of Proposal for Membership in Quekett Microscopical Club.

Mr.

of

being desirous of becoming a Member of this Club, we beg to recommend him for election.

(*on my personal knowledge*).

This Certificate was read 187

The Ballot will take place 187

RULES FOR THE EXCHANGE OF SLIDES.

I. That all Slides be deposited with the Exchange Committee.

II. That not more than two similar Slides be placed in the Exchange Box at one time by any one Member.

III. That the Slides be classified by the Committee into Sections, numbered according to quality.

IV. Members to select from the class in which their Slides are placed, at the ordinary meeting of the Club.

V. Members may leave the selection to the Exchange Committee, if they prefer it.

VI. Slides once exchanged cannot be exchanged again.

VII. A Register shall be kept, in which the Slides deposited shall be entered and numbered, with the date of receipt, and in which exchanges shall also be noted.

VIII.—All expenses incurred in the transmission of Slides or in correspondence respecting them, to be borne by the Member on whose account such charges may be incurred.

Parcels may be addressed—

Mr. John E. Ingpen
192, Piccadilly,
London, W.
[Exchange.]

Note.—As much inconvenience frequently arises from the breakage of Slides in transmission through the Post, the following method is recommended:—Pack the Slides in a small wooden box, which can be obtained of any Optician, tie it securely with string and attach a slip of parchment to one end, sufficiently large to receive the Postage Stamps, Address, and local Post-office Stamps during transmission.

If paper be used as a wrapper to the box, the colour should be *black.*

When twelve or more Slides are sent, they should be packed in a racked box and forwarded by Railway.

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB,

AT

UNIVERSITY COLLEGE, GOWER STREET, LONDON.

1873.—August	*	22
September	12	26
October	10	24
November	14	28
December	12	26
1874.—January	9	23
February	13	27
March	13	27
April	11	25
May	8	22
June	12	26
July	10	24

* No Meeting.

The Ordinary Meetings are held on the *fourth* Friday in each month:—business commences at 8 o'clock p.m.

The Meetings on the *second* Friday in each month are for Conversation and Exhibition of Objects *only*, from 7 to 9.30 p.m.

The ANNUAL GENERAL MEETING will be held on July 24th, 1874, at 8 o'clock, for Election of Officers and other business.

Offices, 192, Piccadilly, W.

Q. M. C.

EXCURSIONS, 1873.

April 5th	BARNES. To meet at Waterloo Station (Richmond line).
April 19th	SNARESBROOK. To meet at Fenchurch Street Station.
May 3rd	ESHER. To meet at Waterloo Station (Main Line).
May 17th	TORRINGTON PARK (for TOTTERIDGE), returning by Mill Hill. To meet at King's Cross Station, G.N.
May 31st	CHISELHURST. To meet at Charing Cross Station.
June 14th	To meet the Croydon Microscopical Club. Particulars will be duly announced.
June 19th	EXCURSIONISTS' ANNUAL DINNER. Arrangements will be duly announced.
June 28th	ELSTREE, returning by Edgware. To meet at St. Pancras Station, at 1.30 P.M.
July 7th	SOUTHEND, Day Excursion. To meet at Fenchurch Street Station, the first Train after 10 A.M.
July 12th	HAMPTON COURT. To meet at Waterloo Station (Main Line).
July 26th	GRAYS. To meet at Fenchurch Street Station.
Sept. 6th	BROMLEY (for KESTON). To meet at Ludgate Hill Station.
Sept. 20th	EAST END (for FINCHLEY COMMON), returning by Southgate. To meet at St. Pancras Station.
Oct. 4th	BRUCE GROVE (for TOTTENHAM MARSHES). To meet at Bishopsgate Low Level Station.
Oct. 18th	WANDSWORTH COMMON. To meet at Clapham Junction, at 3 P.M.

The time of departure from Town, unless otherwise specified, will be THE FIRST TRAIN AFTER TWO O'CLOCK.

F. W. Gay,
F. Oxley,
W. W. Reeves,
W. T. Suffolk,
Excursion Committee.

John E. Ingpen, Hon. Secretary.
Offices, 192, Piccadilly, W.

W. DAVY AND SON, PRINTERS, GILBERT STREET, W.

NINTH REPORT

OF THE

QUEKETT MICROSCOPICAL CLUB,

AND

LIST OF MEMBERS.

MEETING AT UNIVERSITY COLLEGE, LONDON, ON THE SECOND AND FOURTH FRIDAYS OF EVERY MONTH.

OFFICES: 192, PICCADILLY,
LONDON.

July 1874.

(*Extract from original Prospectus, July* 1865.)

"The want of such a Club as the present has long been felt, wherein "Microscopists and students with kindred tastes might meet at stated periods "to hold cheerful converse with each other, exhibit and exchange specimens, "read papers on topics of interest, discuss doubtful points, compare notes of "progress, and gossip over those special subjects in which they are more or "less interested: where, in fact, each member would be solicited to bring his "own individual experience, be it ever so small, and cast it into the treasury "for the general good. Such are some of the objects which the present Club "seeks to attain. In addition thereto it hopes to organize occasional Field "Excursions, at proper seasons, for the collection of living specimens, to "acquire a Library of such books of reference as will be most useful to "enquiring students; and, trusting to the proverbial liberality of Micro- "scopists, to add thereto a comprehensive Cabinet of Objects. By these, and "similar means, the Quekett Microscopical Club seeks to merit the support "of all earnest men who may be devoted to such pursuits; and, by fostering "and encouraging a love for Microscopical studies, to deserve the approval "of men of science and more learned societies."

OFFICERS AND COMMITTEE.

(Elected July 1874.)

President.

Dr. John Matthews, F.R.M.S.

Vice-Presidents.

Dr. Braithwaite, F.L.S., F.R.M.S.
B. T. Lowne, F.R.C.S., F.R.M.S.
Chas. F. White, F.R.M.S.
T. C. White, M.R.C.S., F.R.M.S.

Treasurer.

Robert Hardwicke, F.L.S.

Hon. Secretary.

John E. Ingpen, F.R.M.S.

Hon. Secretary for Foreign Correspondence.

M. C. Cooke, M.A.

Hon. Reporter.

Richard T. Lewis, F.R.M.S.

Committee.

B. Daydon Jackson.
Fred. Oxley.
Frank Crisp, LL.B., B.A., Lond., F.R.M.S.
H. F. Hailes.
F. H. P. Hind.
J. G. Waller.
W. A. Bevington, F.R.M.S.
Dr. Foulerton.
E. T. Newton, F.G.S.
T. Rogers, F.R.M.S.
J. C. Sigsworth, F.R.M.S.
Geo. Williams.

Hon. Librarian.

Alpheus Smith.

Hon. Curator.

G. W. Ruffle.

Excursion Committee.

F. W. Gay, F.R.M.S.
W. W. Reeves, F.R.M.S.
W. T. Suffolk, F.R.M.S.
F. Oxley.

Exchange (of Slides) Committee.

H. F. Hailes.
E. Marks.

Assistant Secretary.

E. Marks.

PAST PRESIDENTS.

	Elected.
EDWIN LANKESTER, M.D., F.R.S. - -	July, 1865.
ERNEST HART - - - - - - -	,, 1866.
ARTHUR E. DURHAM, F.L.S., &c. - -	,, 1867.
,, ,, ,, - - -	,, 1868.
PETER LE NEVE FOSTER, M.A. - -	,, 1869.
LIONEL S. BEALE, M.B., F.R.S., &c. - -	,, 1870.
,, ,, ,, - - -	,, 1871.
ROBERT BRAITHWAITE, M.D., F.L.S., &c.	,, 1872.
,, ,, ,, - - -	,, 1873.

REPORT OF THE COMMITTEE.

Your Committee, in presenting their Ninth Annual Report, have again the pleasing duty of recording the continued prosperity of the Club, and its successful progress in the course marked out by its Founders.

Your Committee gladly avail themselves of the opportunity again afforded them of thanking the Council of University College for the privilege of holding the Meetings of the Club in this room, which privilege has been continued for another year, in the same courteous manner as heretofore.

The Club has lost five members by death during the past year—Mr. F. C. Barnett, Mr. T. W. Burr, Lt.-Col. Jeakes, Mr. H. Lea, and Mr. J. A. Tulk. The loss of Mr. T. W. Burr, who has been for more than six years a most active and useful Member—for five years a member of the Committee, and lately a Vice-President—will be much felt, not only in our Club, but also in the various other scientific Societies to which he belonged; and his ever ready resource and wise counsel will long be remembered by those who have acted with him. There have been also twenty-four resignations, besides which the number of Members has been reduced

by a careful revision of the list, and the removal of the names of many Members who have long ceased to take any interest in the welfare of the Club, and whose Subscriptions are largely in arrear. The result of this scrutiny is as follows:—

Number of Members, June 30th, 1873 ...		564
„ since deceased...	5	
„ „ resigned...	24	
„ removed for non-payment of Subscription	85	114
		450
Number of Members elected since June, 1873		66
Present number		516

It will thus be seen that, though we number fewer Members than last year, there has been no reduction in the real strength of the Club.

The attendance at the Meetings during the past year has attained a very good average, showing that the interest of the Members has not abated. The Ordinary Meetings have assumed a somewhat more formal character than was the case in earlier years, owing to the amount of business to be transacted; but the Conversational Meetings fully keep up the social character of the Club.

The Papers read during the past year have by no means been wanting in interest. The following is a list in the order in which they were read:—

On the Mouths of Insects . .	Mr. B. T. Lowne.
„ Collecting and Preserving Fresh-water Algæ . . .	Dr. Horatio Wood (communicated by Mr. M. C. Cooke).

On Nobert's Tests	Dr. J. J. Woodward.
,, the Histology of Plants, 3rd Paper	Dr. Braithwaite.
,, the "Science Gossip" Section Machine	Mr. Walter White.
,, some Photomicrographs, presented to the Club by . .	Dr. J. J. Woodward.
,, the Sand-blast Cell . . .	Mr. H. F. Hailes.
,, an "Immersion Tube" . .	Mr. Richards.
,, Insect Mounting in Hot Climates	Mr. T. Curties and Mr. Ingpen.
,, an Improved Method of Mounting Opaque Objects . .	Mr. T. C. White.
,, certain Remarkable Organisms observed in the Rat-Flea .	Mr. Furlonge.
,, the Microscopic Structure of Flint and allied substances .	Mr. M. H. Johnson.
,, the Histology of Plants, 4th Paper	Dr. Braithwaite.
,, Section-cutting Machines .	Mr. E. T. Newton.
How to make Thin Covering Glass	Mr. G. J. Burch (communicated by the Secretary).
On a False-light Excluder for Objectives	Mr. Ingpen.
,, The Development of Hydra Vulgaris	Mr. Fullagar, of Canterbury (communicated by Mr. Curties).
,, a New Section-cutting Machine	Dr. Hoggan (communicated at the request of the President).
,, the Histology of Plants, 5th Paper	Dr. Braithwaite.
,, the Histology of Plants, 6th Paper	Dr. Braithwaite.

These Papers appear either *in extenso* or in abstract in the pages of the Journal.

Your Committee cannot pass over the admirable series of Papers "On the Histology of Plants," by our President, without special comment. They form a work of reference of the highest order, of which the Club may well be proud, and

add greatly to the permanent value of the Journal. It is to be hoped that so good an example may be followed by others. A similar series of Papers on Animal Histology would be of great value.

In addition to the foregoing Papers many verbal communications of interest have been made, which are duly recorded in the proceedings.

It is to be wished, however, that Papers should be contributed by a larger number of Members; and your Committee would remind those who are diffident as to the originality or value of their researches, of the first paragraph in the original prospectus of the Club. "This Club has been "established for the purpose of affording to microscopists, in "and around the Metropolis, opportunities for meeting and "exchanging ideas, without that diffidence and constraint "which an amateur naturally feels when discussing scientific "subjects in the presence of professional men." This is well carried out by the Conversational Meetings, at which the advice and assistance of experienced Members with reference to the desirability of bringing researches before the Club in the form of a Paper can always be obtained.

The following additions to the Library have been made during the past year by donation and purchase:—

	PRESENTED BY
Withering's Botany, vols. 1 & 2, 3rd edition, 1796	*Mr. Jas. Watkins.*
Geological Survey of Canada, Report for 1853 to 1856	*Mr. E. Kiddle.*
Davies on Microscopical Mounting, 1st edition...	*Mr. J. F. Tafe.*
Lankester's Half-hours with the Microscope, 1st edition	"
Suffolk on Spectrum Analysis	*The Author.*
Smithsonian Institution Report for 1871	*U. S. Government.*
Cunningham on Microscopical Examinations of Air	*The Author.*

Bailey on Microscopical Examination of Atlantic Coast Soundings	*Messrs. Horncastle and Crisp's Donation.*
Brady's Recent British Ostrocada	”
Brady, Parker and Jones, on the Genus *Polymorphina*	”
Brown on Foraminifera from the Colne Tidal River	”
Busk's Polyzoa of the Crag	”
Carter on New Species of *Squamulina* and *Difflugia*	”
D'Orbigny, Foraminifères du Bassin Tertiare de Vienne	”
Egger, Foraminifera from the Miocene of Ortenburg	”
Ehrenberg, Sub-ocean Forms, &c.	”
Jeffreys, Fourth Report on Shetland Dredgings	”
Jones, T. Rupert, Entomostraca of the Cretaceous Formation	”
” Tertiary Entomostraca	”
Karrer, Foraminiferen des Wiener Sandsteins ...	”
” ” des Wiener Beckens	”
” ” Koslej in Banat	”
Mantell's Foraminifera of Chalk and Flint	”
Mechelin's Iconographie Zoophytologique	”
Parfitt, Protozoa of Devonshire, &c.	”
Parker and Jones' Foraminifera, Coast of Norway	”
Reuss, Foraminiferen Crag d'Anvers	”
” ” der Septarienthrones von Berlin	”
” ” Kanara See.....................	”
” ” Deutschen Oberoligocäno...	”
” ” Westphalischen..............	”
” ” Lagenideen	”
” ” Oberburg in Steiermark ...	”
” ” des Deutschen Septarienthrones..	”
Seguenza, Foraminifera of Messina.................	”
Terquem, Foraminiferès du Lias	”
Weaver, Composition of Chalk Rocks, &c.	”

Beale, How to Work with the Microscope, last edition. A second copy	*By purchase.*
Quarterly Journal of Microscopical Science, new series. Vol 8, up to present time	„
A Monograph of the British Annelids. Part I. Ray Society's Vol. for 1873	*By subscription.*
Popular Science Review	*Mr. R. Hardwicke.*
Monthly Microscopical Journal	„
Science Gossip	„
American Naturalist	*In Exchange.*
The Lens	„
Proceedings of various Scientific Societies and sundry Pamphlets	

The works purchased with the donations of Mr. Horncastle and Mr. Frank Crisp are from the Library of Mr. M. C. Cooke.

The following slides have been added during the past year to the Cabinet of the Club :—

Mr. Curties	146
„ S. Israel	6
„ E. T. Newton . . .	12
„ Watkins	10
„ W. Webb	4
„ W. White	5
	183

The Annual Soirée was held on the 17th of April last, and was no less attractive than on former occasions, having been attended by more than 1,000 visitors. The rooms were less crowded than usual, owing to the increased space kindly placed by the Council of the College at the service of the Club. Upwards of 100 microscopes were exhibited by members, and about 50 by contingents from the South London, the Croydon, the Sydenham, and Forest Hill, and Tower-hill

Microscopical Societies. In addition to this, a brilliant display of microscopes, spectroscopes, stereoscopes, &c., together with the latest improvements in apparatus, and many objects of interest, were kindly contributed by the leading opticians. Your Committee desire to take this opportunity of thanking the numerous gentlemen and firms who exhibited, for their valuable assistance, which contributed greatly to the success of the evening.

During the past year your Committee have given much consideration to the best mode of publishing the Journal. While fully alive to the value of this feature, and the importance attached to it by members residing at a distance and unable to attend the meetings, they do not consider it advisable to guarantee a quarterly issue; but it is their intention to publish at all periods when there is a sufficient accumulation of valuable matter. By the exercise of this discretion, it is considered that an equally satisfactory record can be ensured, with greater economy than hitherto.

The Excursions are still as ably conducted as heretofore, and the attendance thereat has been greater than in previous years. It is to be regretted that more of the results have not been communicated to the Club, but it is satisfactory to know that the best localities near London are kept frequently under observation; while the communication with other local societies on those occasions assists to promote the friendly feeling which it is desirable to encourage between this Club and others of a similar character.

Your Committee take the opportunity of giving their cordial thanks to those gentlemen who devote themselves to the routine of the Club, and thereby keep it in good working order—often at considerable expenditure of time and trouble. To this efficient, though unobtrusive service, no small portion of the success of the Club has always been and still is due.

The Treasurer's report will be found satisfactory, for, though the balance in hand is not large, it is a genuine one, all accounts having been paid to the end of the Club's financial year.

Following its appointed career, improving instruments and methods of manipulation, educating beginners, affording genial intercourse to the experienced, and rendering assistance to each branch of natural science, we may justly congratulate the Club upon its present position,—remembering, however, that this is no time for rest, and that in the great competition now existing, it will require our best exertions and most earnest work to keep up the prestige of the Quekett Microscopical Club, so that it may continue worthy of the honoured name it bears.

PRESIDENT'S ADDRESS,

DELIVERED AT THE ANNUAL MEETING, JULY 24TH, 1874,

BY R. BRAITHWAITE, M.D., F.L.S., &c.

GENTLEMEN,—I now rise to fulfil one of the most difficult duties you have thought fit to impose upon the occupant of this chair, viz., to deliver an annual address; but before endeavouring to do so, I must first tender my thanks to each and all whom I have been accustomed to meet in this room, for the courtesy and kindly feeling which I have always experienced, and to express the wish that the success which has attended your past career may still accompany your future progress.

The guidance of a Society like this, for so long a period as two years, has not failed to impress me with some experience in its requirements, and the knowledge of possibly some slight defects in its work.

The microscope in its present great state of perfection is not an instrument for pastime or amusement only, much less an apparatus for exciting wonder on certain periodic occasions, but rather a master-key which enables the possessor to pass beyond the region of familiar things, and unlock the gates of a great unknown land that stretches away on every side, and which numbers as its inhabitants every thing created.

Unless you are prepared to use it for the advancement of knowledge, what does it profit you? and unless by previous study you are prepared to understand what you see, what does it profit you?

> I recognize the man of learning here,
> What you touch not, lies not within your sphere;
> What you grasp not, does not exist for you;
> What you count not, most surely is not true;
> What you weigh not, devoid of weight you call;
> What you coin not, won't pass with you at all.

With these thoughts in mind, I have, as occasion offered endeavoured to sketch out for you a plan of work to be done in connexion with the Vegetable Kingdom. How small a proportion this bears to the corresponding work required for the animal world, I need not mention; this I leave to my successors; it is for you to fill in the details. Having then, put before you some of the leading features in the structure of plants, perhaps on the last occasion when it will be my privilege to address you, I may not unprofitably occupy your time with a few supplementary remarks on the function of the various organs—that is, the *Physiology of Plants.*

We have seen that the first element in the formation of a plant is a cell, originating from the combination of carbonic acid and water on the one hand into gum or vegetable jelly, and of carbonic acid and ammonia on the other into protoplasm or albumen; that cells increase and multiply by division and then become changed, for they extend in dimensions, acquire deposit here, undergo resorption there, until all the different tissues are formed; yet, just as in the animal kingdom, not one of these conditions is met with—transient, it may be, in the object before us—but is the permanent state in the life of some other organism; and on this rests the foundation of the grand theory of evolution. To no subject could your microscopes be turned with greater profit,

than to trace out the changes in every organ, from the embryonic state to its full development.

Each cell acts as an independent organism, absorbing fluids and gases from without, and elaborating in its interior new substances, some for the support of the plant, some stored up for future use, either in the life of the individual or of other orders of creation, some excreted as useless. In the higher plants we have great differentiation of tissues and great diversity in the functions which each is called on to perform: one set constituting cambium is occupied solely with the growth of the plant, while another is preparing sugar or starch or chlorophyl, yet guided by the inherent vital principle, each plays its proper part without interference with its neighbour, and we cannot imitate the process.

Nägeli has attempted to explain the mechanism of endosmose and exosmose, by supposing that the walls of a cell consist of inconceivably minute particles, each of which, however, is surrounded on all sides by a fluid envelope; other fluids will readily pass through this, and the entry of water would thus cause the molecules to be moved farther from each other and distension would result, while the passage of water outward would bring them closer together, and we should then have contraction.

For the germination or first process of growth of the embryo plant which lies dormant in every fertile seed, certain conditions are necessary, without which it fails to appear. These are moisture, heat, and atmospheric air; water is absorbed by the cells, and after softening their texture, it next sets about the solution of the nutritive material stored up in the seed, at the same time the cells continue to swell, and soon burst open the hard testa or pericarp by which they had been protected; the amount of heat required is variable, depending on the climate of the country of which the plant is a native; and that air is necessary, is proved by

placing seeds in an atmosphere of nitrogen or hydrogen, when they fail to germinate.

Seeds germinate more rapidly in shade than in light, and the process is materially influenced by the chemical rays, for while blue light accelerates, yellow rays retard it. The decomposition of carbon is also due to the action of light, and hence it is necessary for the formation of wood and chlorophyl; a due balance of the chemical and luminous rays is also required for the proper development of flowers and perfection of fruit. Thus you see how nicely adapted are the operations of nature to the co-existing external conditions of the world around: the seeds have laid dormant all through the long winter, or even stored up for years in the granary, and the embryo bud presents no signs of its existence, yet with the first rush of spring the requisite conditions are at hand, the earth is saturated with moisture, the sun with as yet a low elevation imparts sufficient heat with a moderate supply of light; but with the full blaze of summer power the flowers attain full development of form and hue, to pass under the calorific and chemical forces of autumn into ripened fruit, again to lie dormant for the winter.

The first alteration set up in the seed is in the nitrogenized matter, diastase being formed, which acts as a ferment, and the starch is converted into dextrine and grape sugar, and thus rendered soluble and capable of assimilation; carbonic acid is also evolved from combination of oxygen with the carbon of the seed, and as in all other cases of chemical action, heat is at the same time produced.

Numerous experiments and theories have been devised to explain the cause of the constant downward growth of the radicle and upward growth of the plumule, but none are satisfactory; and we must again fall back on vital force, guided by Divine Intelligence.

The roots of plants only grow at their apex, and here the

absorbing cells are chiefly placed, and cellular hairs or processes of the epidermis which take the greatest share in the action; these soon die and are replaced by a corky layer, while fresh epidermis and hairs are again thrown out at the apex. By these, water holding various salts in solution is constantly being drawn up for the nourishment of the plant and supply of the inorganic elements required, which can only be assimilated when presented to the tissues in a liquid state. Epiphytal plants, by their aërial roots, take up nutriment from the atmosphere alone; while parasites, which can only live on the juices of other plants, send cellular prolongations into the tissues of the host, through which they suck out their nutriment, and thus destroy their supporter.

The leaves are arranged in such a way as to be fully exposed to the influence of air and light; and thus we find that, however numerous, there is no overlapping or interference one with another. The fluids carried up from the root are elaborated in the cells and vessels of the leaves, and undergo important changes; and again they absorb carbonic acid, ammonia, and water, and give off water, oxygen, and other gases. Absorption of fluid by the surface of leaves takes place most readily when the cuticle is thin and the stomata numerous; and this is the usual condition on the under surface. Dew and rain are thus taken up, and pass down the spiral vessels and parenchyma, and through the intercellular spaces; carbonic acid is also rapidly removed by leaves, and this appears to go on continuously. The young cuticle readily absorbs water, but this power is greatly diminished by age, as it then becomes indurated and impregnated with waxy deposit.

Transpiration or exhalation of watery fluid is also carried on by leaves, the amount varying with the structure of the leaf and the surrounding atmospheric conditions. When hard and dry, or when the cuticle is dense or supplied with

few stomata, as we see in the olive tree and many acacias, transpiration is small in quantity, and such plants are most frequent in arid regions. A dense woolly covering of hairs also resists drought, the fine cellular hairs absorbing dew, and in dry weather forming a flat coat which resists transpiration. The corky thickening which all epidermal cells undergo seems a wise provision to prevent exhalation, which is thus carried on solely by the stomata.

Besides water, the leaves of plants give off gases, and thus are most important organs, as it is on this wise provision of nature that we and all the animal creation depend for the purity of the air we breathe. Priestley first discovered that plants enclosed in air vitiated by breathing restored it to its original purity; then Ingenhousz proved that plants give out oxygen, but only during daylight, that it is greatest in sunshine, and ceases at night, that poisonous plants behave in this respect like harmless, that it is from old leaves and the under surface that the largest amount is eliminated, and that aquatic plants give off the most.

De Saussure determined that although carbonic acid was consumed during the day, it was given off at night; and that Fungi, and blanched parts of plants, as well as leafless plants, exhaled carbonic acid. The carbonic acid appears to be manufactured by vital processes going on within the plant, and not by direct combination of the carbon of the plant with the oxygen of the air. It is believed that some nitrogen is also given off by plants, no doubt resulting from the decomposition of absorbed ammonia. The sap absorbed by the roots, containing inorganic matters in solution, reaches the leaves and is exposed to air and light, water is transpired extensively, and the inorganic matter not required for the growth of the plant and its secretions is stored up in the leaves, increasing in quantity with their age, as we find by the weight of ash left after burning them; this consists of

salts of lime, potass, magnesia, &c., and thus the fall of the leaf is not an useless process in the economy of nature, but a means of restoring again to the earth large quantities of material for the nutriment of plants in the following season.

The fluids absorbed by the roots are quickly diffused through the plant and carried up to the leaves, which by exhalation constantly require a fresh supply, and draw it upward to replace the loss, thus promoting a general movement through every part of the plant. In cellular plants the circulation is general throughout the tissues; in ferns the fluid absorbed passes along the loose cellular tissue around the scalariform vessels; in Monocotyledons it ascends through the elongated cells surrounding the spiral vessels, which ordinarily contain air; in Dicotyledons the spring sap flows gradually up the stem, at first filling the spiral vessels, but as the leaves expand they exhale fluid, and then the spiral vessels contain air, and the sap passes by the newer wood vessels and cells; and in summer we have the elaborated sap sent back from the leaves in an external current between the bark and the wood, from whence it is diffused through all the active cells and vessels of the stem.

The first true insight into the reproductive process in plants appears to have been made known in this country by Grew in a paper read before the Royal Society in 1676, and next adopted by Ray in 1694. Linnæus in 1736 gave to the world his celebrated sexual system, founded on the reproductive organs; but although it was known that pollen was necessary for impregnation, its *modus operandi* was not understood, until in 1823 Amici discovered the pollen tubes, and Robert Brown traced them to the nucleus of the ovule.

To the important part played by insects in the fertilization of plants I need not here refer, nor to the various modifications in the structure of the style or stigma, designed to fulfil special ends; but it may be of interest to place before

you a very brief summary of the more secret part of the process, since our knowledge thereof has been gained entirely by the careful use of the microscope.

During the maturation of the pollen the stigma becomes enlarged, its central tissue looser, and a viscid secretion bathes its surface, the ovule also alters, for one of its central cells becomes greatly enlarged, so as to form the embryo-sac, and at the end of this sac, next to the micropyle, certain delicate free nucleated cells are produced, which have been termed embryo-vesicles; and now all is prepared for the crowning purpose of the plant's existence.

In Cryptogams, the first sign of a special function in cells is seen in the lower algæ, in the process of conjugation, by which a tube is thrown across from adjacent filaments, and the endochrome of one cell passes over into the opposite one and a spore produced in it or in the intermediate tube.

Passing higher in the scale, we find different kinds of reproductive organs: antheridia containing cells with a moving ciliated spermatozoid in each, and archegonia containing a germ-cell. In all these cases (Hepaticæ, Mosses, and Ferns) the spermatozoids enter the archegonium and reach the central vesicle, which is thus impregnated; they then lose all motion, and thus precisely correspond with the behaviour of spermatozoa in the animal ovum.

Taking a Fern as the type, we find the spore grows into a lobulated prothallium, on the under surface of which anthe-ridia and archegonia are produced, the former consisting of a papilla containing free cells which are discharged at an opening in the apex; these then burst and liberate a ciliated spiral filament, the spermatozoid. The archegonia are fewer and larger, consisting of ten or twelve cells, and have a central canal leading to a large globular germ-cell embedded in the prothallium. The spermatozoids passing down the canal come in contact with the central cell of the arche-

gonium, and the inner mouth of the archegonial canal closes by swelling of the adjacent cells. The fertilized germinal vesicle enlarges until it fills the central cell and then begins to divide, and from it the permanent stem of the fern commences its growths, throws out radicles, and the prothallium withers away.

Passing next to Phœnogamous plants, we find the reproductive organs evident enough, polleniferous stamens and ovuliferous pistils; but we will first take the Gymnosperms or Cycads and Conifers, in which impregnation takes place by direct contact between the pollen and ovule, in Cycads the naked ovules being placed on the margin of modified leaves, while in Conifers the scales covering the seeds are regarded as bracts.

In Conifers, the pollen grains are applied to the large micropyle of the ovule without the intervention of a stigma, their tubes then traverse the delicate cells of the nucleus and reach the embryo-sac; the sac enlarges and very slowly becomes filled with endosperm cells. Next, three to six cells at the micropylar end enlarge and form corpuscles, each of which is at first separated from the inner wall of the embryo-sac by a simple cell which divides into four by cross walls, and in the middle of these a passage is left leading to the corpuscle. The pollen-tubes keep slowly growing, pass through the tissue of the nucleus, then perforate the wall of the embryo-sac, and on between the four cells to the corpuscle, which they impregnate; a cell at the lower end of the corpuscle then enlarges and forms the embryonal vesicle, a free cell in which divides into eight cells, forming a short cylindric pro-embryo. The four lower cells of this, by elongation of the upper, are pushed into the nucleus, the upper now appearing as suspensors, each of the cells at their lower ends becoming an embryo. There are thus four times as many embryos as corpuscles, but usually only one developes

to that of a perfect seed. Twelve or thirteen months elapse between the entrance of the pollen-tubes and production of corpuscles.

In the Angiosperms, or great mass of flowering plants, the pollen falls on the viscid stigma, the extine bursts, and the intine is protruded as a tube, which pushes on down the style until it reaches the ovule, sometimes a short process rising from the ovule to meet it; still pushing on, it enters the micropyle and reaches the embryo-sac. Here it comes in contact with the already formed embryonal vesicle, which after impregnation divides into two cells by a transverse partition, the lower forming the embryo-globule, while the upper elongates and becomes the suspensor.

In the process of impregnation a large amount of oxygen is absorbed and carbonic acid evolved, and an elevation of temperature takes place; the pollen is shed at the time the greatest amount of heat is produced, and the stamens have a higher temperature than the pistils. In certain orders also, above all in the Araceæ, the evolution of heat is most marked. In our common *Arum maculatum*, during the expansion of the spathe, the temperature has been found to be 15 to 20° above that of the air, in *Arum dracunculus* as much as 31°, but in *Colocasia odora* growing in the Isle of France, Hubert found that a thermometer in the centre of twelve spadices stood at 142°, while the temperature of the air was 74·75°.

A far more important point, however, to be borne in mind in the growth of plants, is the absorption of light and heat, since the formation of the tissues, the production of chlorophyl, the gay tinting of the flowers, the induration of the wood, and all the manifestations of plant-life are solely the result of the transformation of heat into mechanical work; and never do I muse over my study fire, but the thought ever recurs, that here from the coal-plants is brought back to me, visibly, sensibly, those very sunbeams which shone

forth in the bygone ages that preceded man's appearance on the earth.

As we know that no matter is ever lost, as we know that no force is ever lost, so have we reason to believe that no thought is ever lost; let it then be your aim so to utilize the constituents of this material universe around you, that they may react on your thoughts and guide them into good and useful work. Pray that the mystery of life may lead you to look with reverence on every flower which enlivens your path, and with means and opportunity to explore its most intimate structure, you may be lifted above the commonplace things of this world,—above the waxen flowers, the worship of the passing hour,—to find at last that peace of mind which passeth all understanding.

He prayeth best, who loveth best
  All things both great and small;
For the dear God who loveth us,
  He made and loveth all.

QUEKETT MICROSCOPICAL CLUB, JUNE 30TH, 1874.

TREASURER'S STATEMENT OF ACCOUNT.

RECEIPTS.

	£	s.	d.
To Balance in hand - - - - -	98	19	5
,, Life Subscription to be invested -	10	0	0
,, Subscriptions received - - -	208	0	0
,, Donation from Mr. F. Crisp - -	5	0	0
,, Cash received from Sale of Journal -	1	7	10
	£323	7	3

PAYMENTS.

	£	s.	d.
By Printing and Stationery - - -	23	1	0
,, Postage - - - - - - -	12	14	1
,, Attendance - - - - - -	12	12	6
,, Purchase of Property - - - -	19	11	4
,, ,, of £11 : 0 : 5 New 3 per cent. Annuities - - - - -	10	0	0
,, Petty Expenses (including Assistant-Secretary, 3 Quarters, £15, and Gas, £5 15s.) - - - - -	24	10	4
,, Soirée expenses - - - - -	67	1	0
,, Journal (Nos. 21 to 26) - - -	96	2	1
,, Balance in hand - - - -	57	14	11
	£323	7	3

Amount standing Invested in New 3 per Cent. Annuities, £30.

We, the undersigned, having examined the above statement of Income and Expenditure, and the Vouchers referring thereto, hereby certify that the said Account is correct.

WM. HAINWORTH, JUN., }
H. H. DOBSON, } *Auditors.*

HONORARY MEMBERS.

Date of Election.	
Oct. 25, 1867	Guiseppe de Notaris, *Professor of Botany, &c., &c.,* Rome.
Jan. 24, 1868	Arthur Meade Edwards, M.D., 314 West Thirty-fourth-street, New York.
Mar. 19, 1869	Rev. E. C. Bolles (*Ex-President of the Portland Society of Natural History*), Brooklyn, New York.
July 26, 1872	S. O. Lindberg, M.D., Professor of Botany, University of Helsingfors, Finland.
July 26, 1872	Prof. Hamilton L. Smith, President of Hobart-College, Geneva, New York, U.S.A.
July 26, 1872	J. J. Woodward, Assist. Surgeon, U.S.A. War Department, Surgeon General's Office, Washington.
July 24, 1874	Sharpey, W., M.D., F.R.S., 33 Woburn-place, W.C.

LIST OF MEMBERS.

Date of Election.	
Sept. 24, 1869	Ackland, William, L.S.A., F.R.M.S., 3 Holborn-viaduct, E.C.
Nov. 27, 1868	Adkins, William, 270 Oxford-street, W.
Mar. 23, 1866	Allbon, W., F.R.M.S., 525 New Oxford-street, W.C.
Oct. 28, 1870	Allen, Rev. Francis H., Ditchingham, Bungay, Norfolk.
Sept. 27, 1867	Allen, John T., 57 Cross-street, Islington, N.
July 26, 1872	Alstone, John, 140 Rye-lane, Peckham, S.E.
Dec. 17, 1869	Ames, George Ackland, F.R.M.S., Union Club, Trafalgar-square, W.C.
Sept. 25, 1868	Andrew, Arthur R., 3 Neville-terrace, Fulham-road, S.W.
Dec. 22, 1865	Andrew, F. W., 3 Neville-terrace, Fulham-road, S.W.
Oct. 25, 1872	Andrew, F. W., jun., 3, Neville-terrace, Fulham-road, S.W.
Sept. 22, 1865	Annett, James, Hampton, Middlesex.
July 7, 1865	Archer, J. A., 172 Strand, W.C.
Feb. 23, 1872	Atkins, A., M.R.C.S., 232, Mile End-road, E.
Feb. 23, 1872	Atkins, A., jun., L.R.C.P., 232 Mile-end-road, E.
Dec. 22, 1865	Atkinson, John, 33 Brook-street, W,
Feb. 26, 1869	Atkinson, William, F.L.S., 47 Gordon-square, W.C.
Mar. 27, 1868	Aubert, Alfred, Lloyds, E.C.
Nov. 25, 1870	Baber, Edward Cresswell, L.R.C.P., M.R.C.S., F.R.M.S., 34 Thurloe-square, S.W.

Date of Election.

June 26, 1874	Badcock, John, 2 Banbury-road, South Hackney, E.
July 25, 1873	Baguley, John E., 51 Thistle-road, Brompton, S.W.
May 22, 1868	Bailey, Captain L. C., R.N., F.R.G.S., R.A.S., Topographical Department, New-street, Spring-gardens, S.W.
Dec. 27, 1867	Bailey, John W., 75 Broke-road, Dalston, E.
April 24, 1868	Baker, Chas., F.R.M.S., 244 High Holborn, W.C.
Feb. 28, 1873	Baker, George H., M.R.C.S., 14 Mare-street, Hackney, E.
Oct. 24, 1873	Baker, Thomas John, M.R.C.S., L.S.A., 18 Junction-road, Highgate-hill, N.
Mar. 24, 1871	Baly, Charles, 75 Margaret-street, W.
Dec. 27, 1872	Barnard, Herbert, 33 Portland-place, W.
April 22, 1870	Barnes, Chas. Barritt, 66 Old Broad-street, E.C.
Sept. 27, 1872	Bartlett, Edward, jun., 38 Connaught-square, W.
Aug. 22, 1873	Bartlett, Wm., L.D.S., M.R.C.S., 1 Cambridge-villas, Southall, W.
June 23, 1871	Bartlett, Wm. P., 2A Eastbourne-terrace, W.
May 22, 1874	Bate, Dr. George Paddock, 412 Bethnal Green-road, E.
Mar. 27, 1874	Beach, Richard J., 59 Ashburton-grove, Lower Holloway, N,
June 24, 1870	BEALE, LIONEL S., M.B., F.R.S., F.R.M.S., 61 Grosvenor-street, W.
June 25, 1869	Beale, Charles J., Box 110, Post Office, Toronto, Canada.
May 28, 1869	Bean, Charles E., Brooklyn-house, Goldhawk-rd., Shepherd's Bush, W.
Oct. 26, 1866	Beck, Joseph, F.R.M.S., 31 Cornhill, E.C.
May 26, 1871	Bedwell, Fras. Alfred, M.A., Cantab., F.R.M.S., Bridlington, Hull.
May 24, 1872	Bennett, W. H., St. George's Hospital, S.W.
Mar. 24, 1871	Bentley, Algernon Royds, 9 Portland-place, W.
Dec. 27, 1867	Bentley, C. S., Hazelville Villa, Sunnyside-road, Hornsey-rise, N.
May 22, 1868	Berney, John, F.R.M.S., 61 North-end, Croydon.
Oct. 23, 1868	Bevington, W. A., F.R.M.S., 113 Grange-road, S.E.

Date of Election.	
June 24, 1870	Birch, A. E., 47 Halliford-street, Islington, N.
July 28, 1871	Bishop, Wm., 1 Alma-villas, Wood-green, N.
Feb. 23, 1866	Blake, T., 6 Charlotte-terrace, Brook-green, Hammersmith, W.
Mar. 19, 1869	Blankley, Frederick, F.R.M.S., 23 Belitha-villas, Barnsbury, N.
Oct. 24, 1873	Bolton, Major Frank, 21 Victoria Mansions, S.W.
Sept. 27, 1872	Borthwick, Lord, 35 Hertford-street, Mayfair, W.
April 22, 1870	Bossy, Alfred Horsley, Prospect Cottages, Stoke Newington, N.
Nov. 27, 1868	Boustead, James, Stourfield Lodge, Effra-road, Brixton, S.E.
May 22, 1874	Box, Edward Gaspar, Queen's-road, Bayswater, W.
Oct. 23, 1868	Brabham, T., 61 Castle-street, Leicester-sq., W.C.
June 26, 1874	Brady, Henry, 96 Palace-gardens-terrace, W.
Dec. 22, 1865	Brain, T., 1 Upper Vernon-street, Lloyd-square, W.C.
Oct. 27, 1865	BRAITHWAITE, R., M.D., M.R.C.S.E., F.L.S., F.R.M.S. (*Vice-President*), The Ferns, Clapham-rise, S.W.
Mar. 28, 1873	Bridgman, Frank G., 18 Queen Anne-street, Cavendish-square, W.
Dec. 27, 1872	Bridgman, William Kencely, 69 St. Giles's-street, Norwich.
May 27, 1870	Brigham, H. G., St. George's Hospital, S.W.
May 27, 1870	Brown, George Dransfield, M.R.C.S., Uxbridge-road, Ealing, W.
May 22, 1868	Brown, W. J., 4 Malbro-terrace, Maple-road, Penge, S.E.
May 26, 1871	Browne, George, 80 Pratt Street, Camden-town, N.W.
Feb. 27, 1872	Browne, Rev. Thomas Henry, F.R.M.S., High Wycombe, Bucks.
May 24, 1867	Browne, H., 40 Camden-square, N.W.
Sept. 27, 1872	Bugby, Wm., 3 Wilton-villas, Uxbridge-road, W.
May 22, 1874	Burgess, John James, 1 Copthall-chambers, E.C.
Sept. 28, 1866	Burgess, J. W., 1 Sylvester-villas, Markhouse-rd., Walthamstow, E.
Feb. 23, 1866	Burgess, N., 1 Sylvester-villas, Markhouse-rd., Walthamstow, E.

Date of Election.	
June 25, 1869	Burgess, W. F., Guy's Hospital, S.E.
Aug. 26, 1870	Burgess, Martin, 10 Ashby-place, Brockley-road, S.E.
May 22, 1874	Burnham, F. C., 78 Farringdon-street, E.C.
Feb. 27, 1874	Burton, Thomas W., 46 King Edward's-road, South Hackney, E.
Sept. 27, 1872	Bush, Wm., The Grove, East Dulwich, S.E.
June 14, 1865	Bywater, Witham M., F.R.M.S., 5 Hanover-square, W.
May 24, 1867	Callaghan, James, 278 Commercial-road, Peckham, S.E.
May 22, 1874	Callaghan, William Edmund, 18 South Audley-street, W.
Sept. 25, 1868	Capel, Charles C., North Cray-place, Chislehurst, Kent.
May 22, 1874	Carruthers, Herbert, 4 Sussex-villas, Richmond, Surrey.
May 26, 1871	Catchpole, Robert, 101 Lancaster-road, Notting-hill, W.
Feb. 28, 1873	Chapman, A. W., Beaufoy Lodge, 32 St. John's-wood-road, N.W.
Dec. 27, 1867	Chapman, W. C., 39 Granville-square, W.C.
May 22, 1874	Clayton, James, 30 Hemingford-road, N.
May 26, 1871	Coales, Dr. R., 119 Gower-street, W.C.
May 22, 1868	Cocks, W. G., 18 Kent-villas, Grange-road-east, Dalston, E.
May 28, 1869	Cole, Walter B., F.R.M.S., St. John's-terrace, Weymouth.
April 24, 1874	Cole, Wm., 1 The Common, Stoke Newington, N.
May 23, 1873	Coles, Alfred K., Stamford-hill, N.
Jan. 25, 1867	Coles, Ferdinand, A.P.S., 248 King's-road, Chelsea, S.W.
April 23, 1869	Collings, Thomas P., 38 Surrey-street, Strand, W.C.
July 7, 1865	Collins, C., F.R.M.S., 157 Great Portland-street, W.
Feb. 23, 1872	Colvin, Alexander, Barham Lodge, Weybridge, Surrey.

Date of Election.	
Sept. 27, 1872	Connolly, Charles T., L.S.A., 3 Church-hill-villas, Wood-green, N.
June 14, 1865	Cooke, M. C. (*Hon. Sect. for Foreign Correspondence*), 2 Grosvenor-villas, Junction-road, Upper Holloway, N.
Feb. 22, 1867	Cooper, Frank W., L.R.C.S. Edin., Leytonstone, E.
Mar. 23, 1869	Coppock, C., F.M.S., F.R.M.S., 31 Cornhill, E.C.
June 27, 1873	Corbett, Alfred L., 103 Fentiman-road, Clapham, S.W.
Feb. 27, 1874	Cornish, James, The Infant Establishment, Hornsey-road, N.
May 28, 1869	Cottam, Arthur, F.R.A.S., Office of Woods, Whitehall, S.W.
July 26, 1872	Cowan, Thos. Wm., Hawthorn-house, Horsham, Sussex.
July 23, 1869	Creer, Edwin A. O., 2 Albany-place, Commercial-road East, E.
Aug. 28, 1868	Crisp, Frank, L.L.B., B.A. Lond., F.R.M.S., 134 Adelaide-road, N.W.
Dec. 23, 1870	Crisp, John S., F.R.M.S., 62 Camberwell-road, S.E.
Feb. 27, 1868	Crook, Thomas, F.R.M.S., 3 Grosvenor-villas, Cleveland-road, Surbiton, S.W.
Sept. 28, 1866	Crouch, Henry, F.R.M.S., 66 Barbican, E.C.
May 25, 1866	Curties, T., F.R.M.S., 244 High Holborn, W.C.
April 26, 1872	Curwen, Herbert, Workington House, Upton, Essex, E.
Mar. 22, 1872	Daintrey, George, 43 Oakley-road, Southgate-road, W.
June 25, 1868	Darnley, D. Rowland, 12 John-street, Bedford-row, W.C.
Oct. 24, 1873	Dashwood, Horace, 47 Milner-street, N.
June 23, 1871	D'Aubney, Thos., Shepherdess-walk, Hoxton, N.
May 23, 1873	Davey, Robert R. F., War-office, Pall-mall, S.W.
Oct. 24, 1873	Davies, John Russell, Alpha-villa, London-road, Clapton, E.
Oct. 22, 1869	Davis, Henry, 19 Warwick-street, Leamington.

Date of Election.	
Dec. 23, 1870	Dawson, George M., Royal School of Mines, S.W.
Jan. 22, 1869	Deed, Alfred, 94 King Henry's-road, Primrose-hill, N.W.
June 26, 1868	Dickens, Charles, Latimer-house, Hadley, Middlesex.
Jan. 23, 1874	Doble, Edmund Mohun, 12 Mount Ararat-villas, Richmond, Surrey.
Nov. 24, 1865	Dobson, H. H., F.R.M.S., Pelham-lodge, Alexandra-road, St. John's-wood, N.W.
July 26, 1872	Doggett, Ernest, 3 Liquorpond-street, E.C.
Nov. 27, 1868	Douglas, Rev. R. C., Manaton Rectory, Moreton-hampstead, Exeter.
Jan. 28, 1870	Dowson, Edward, M.D., M.R.C.S., F.R.M.S., 117 Park-street, Grosvenor-square, W.
July 28, 1871	Drew, G. C., Milton-house, Cassland-road, South Hackney, E.
Dec. 23, 1870	Duck, William A., 4 High-street, Vauxhall-cross, S.E.
April 26, 1872	Dudgeon, R. E., M.D., 53 Montagu-square, W.
Oct. 25, 1872	Dunning, Chas. G., 53 Crowndale-road, Camden-town, N.W.
Sept. 22, 1865	Durham, Arthur E., F.L.S., F.R.M.S., 82 Brook-street, Grosvenor-square, W.
Nov. 23, 1866	Durham, F., M.B., F.R.C.S., 14 St. Thomas's-street, S.E.
Sept. 25, 1868	Eddy, James Ray, F.R.M.S., F.G.S., Carleton-grange, Skipton, Yorkshire.
June 28, 1867	Edmonds, R., 178 Burrage-rd., Plumstead, S.E.
May 26, 1871	Enock, Frederick, 14 Medina-rd., Holloway, N.
Sept. 24, 1869	Epps, Richard, M.R.C.S., 89 Great Russell-street, W.C.
Dec. 18, 1868	Eyre, Samuel, Belmore-lodge, Priory-grove, South Lambeth, S.W.
June 26, 1874	Fardon, Edward Ashby, 80 Cambridge-street, Pimlico, S.W.
July 25, 1873	Fase, Rev. Henry J., 57 Winchester-street, Pimlico, S.W.

Date of Election.	
Mar. 27, 1868	Field, James, High-street, Highgate, N.
July 26, 1867	Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh-house, Highbury New-park, N.
Jan. 23, 1874	Flux, E. H., 1 West-hill, Highgate, N.
Jan. 27, 1871	Forshaw, Thomas, jun., the Bower, Bowden, Altrincham, Cheshire.
Aug. 4, 1865	Foster, Peter le Neve, M.A. Cantab., F.R.M.S., Society of Arts, Adelphi, W.C.
Mar. 24, 1871	Foulerton, Dr. J., Thatched House Club, Saint James's-street, S.W.
Dec. 28, 1866	Fox, C. J., F.R.M.S., 16 Cork-street, Bond-street, W.
July 26, 1872	Francis, T. Harper, 335 Gray's-inn-road, W.C.
June 23, 1871	Freeman, Henry E., 1 Rose-villas, Colney-hatch-road, Wood-green, N.
May 26, 1871	Freshwater, Thos. E., 2 Charlotte-street, Caledonian-road, N.
Feb. 26, 1869	Fricker, C. J., 4 Westow-hill-terrace, Upper Norwood, S.E.
May 22, 1868	Fryer, G. Henry, 14 The Terrace, Kilburn, N.W.
Oct. 26, 1868	Furlonge, W. H., Coed Mawr-house, Holywell, Flintshire.
July 28, 1871	Furneaux, John Richard, Boxgrove-house, Mayow-park, Forest-hill, S.E.
Nov. 25, 1870	Fyfe, Andrew, M.D., 42 Montpelier-square, S.W.
Mar. 19, 1869	Gann, James W., 171 Fenchurch-street, E.C.
Mar. 25, 1870	Garden, Robert Spring, 42 Carlton-hill, St. John's-wood, N.W.
May 25, 1866	Gardiner, G., F.M.S., 244 High Holborn, W.C.
April 24, 1868	Garnham, John, F.R.M.S., 123 Bunhill-row, E.C.
July 7, 1865	Gay, F. W., F.R.M.S., 113 High Holborn, W.C.
Sept. 22, 1865	Geddes, P., Millbank, Westminster, S.W.
Jan. 28, 1870	Gellatly, Peter, Loughton, Essex.
July 26, 1867	George, Edward, F.R.M.S., 12 Derby-villas, Forest-hill, S.E.
July 22, 1870	Gibson, Joseph F., F.R.M.S., 3 Furnival's Inn, E.C.

Date of Election.	
June 14, 1865	Gibson, W., 273 Regent-street, W.
June 27, 1873	Glasspoole, Hampden G., 12 Hunter-street, Brunswick-square, W.C.
Nov. 22, 1867	Golding, W. H., 19 Regina-road, Tollington-park, N.
Dec. 23, 1870	Goldsmith, John Charles, 5 America-square, E.C.
Oct. 26, 1866	Gooch, James W., 23 High-street, Eton.
Nov. 22, 1872	Goodchild, J. E., 114 Englefield-rd., Islington, N.
Aug. 23, 1872	Goode, A., Whitehall-lane, Woodford, Essex.
Dec. 22, 1865	Goode, W., 729 Wandsworth-road, S.W.
April 26, 1872	Goodinge, James Wallinger, 18 Aldersgate-street, E.C.
Mar. 27, 1866	Gray, S. Octavus, 44 Doughty-street, W.C.
Dec. 22, 1865	Gray, W. J., M.D., F.R.M.S., 41 Queen Anne-street, Cavendish-square, W.
May 22, 1874	Green, G., 6 Helmet-row, St. Luke's, E.C.
Jan. 28, 1870	Green, Nathaniel E., 3 Circus-road, St. John's-wood, N.W.
Oct. 28, 1870	Greene, William Asbury, Parkshot, Richmond, Surrey.
Oct. 23, 1868	Greenish, T., F.R.M.S., 20 New-street, Dorset-square, N.W.
Oct. 23, 1868	Gregory, Henry R., 38 Welbeck-street, W.
May 23, 1873	Gregory, William, 406 Strand, W.C.
May 22, 1874	Grey, Ernest, 19 Southill-park, Hampstead, N.W.
June 26, 1874	Gritton, John Hall, 18 Northampton-park, Canonbury, N.
June 26, 1874	Gritton, Joseph, 18 Northampton-park, Canonbury, N.
July 24, 1868	Groves, J. W., F.R.M.S., 25 Charlotte-street, Bedford-square, W.C.
July 24, 1868	Grubbe, E. W., C.E., 49 Queen's-gardens, Hyde-park, W.
Jan. 27, 1871	Guimaraens, Augustus de Souza, F.R.M.S., 120 Ossulton-street, Euston-square, N.W.
Mar. 22, 1872	Guyton, Joseph, 5 Apsley-terrace, Acton, W.
Feb. 28, 1873	Haddon, Alfred C., 3 Bouverie-street, E.C.
Jan. 23, 1874	Hadland, J. H., 11 King William-street, E.C.

Date of Election.	
June 14, 1865	Hailes, Henry F., 7 Haringay-road, Hornsey, N.
Aug. 26, 1870	Hailstone, Robert H., 35 Walworth-road, S.E.
Feb. 23, 1867	Hainworth, W., jun., Clare-villa, Cricketfield-road, Lower Clapton, E.
Mar. 19, 1869	Hall, Marshall, Capt., F.G.S., F.C.S., F.R.M.S., New University Club, St. James's-street, S.W.
Feb. 22, 1869	Hammond, A., 3 Alexander-road, Marine-town, Sheerness.
Oct. 22, 1869	Harcourt, Cyril B., St. George's Hospital, S.W.
June 14, 1865	Hardwicke, Robert, F.L.S. (*Treasurer*), 192 Piccadilly, W.
Jan. 23, 1874	Hardy, James Daniel, 11 Clarence-villas, Clarence-road, Clapton, E.
Sept. 28, 1866	Harkness, W., F.R.M.S., Laboratory, Somerset-house, W.C.
June 23, 1871	Harris, Edward, F.R.M.S., Rydal-villa, Langton-grove, Upper Sydenham, S.E.
July 26, 1872	Harrod, John, 3 Great Tower-street, E.C.
Nov. 26, 1869	Hart, Edward, Highbury New-park, N.
Nov. 24, 1871	Hawker, Charles, M.D., 2 Albion-terrace, White Horse-lane, Stepney, E.
June 24, 1870	Hawkins, Samuel J., Bleak Dean, near Heptonstall, Manchester.
June 28, 1867	Hawksley, Thos. P., 4 Blenheim-street, New Bond-street, W.
May 27, 1870	Haywood, Henry, Dartmouth-terrace, Rotherhithe, S.E.
Aug. 23, 1872	Hembry, F. W., F.R.M.S., 7, St. John's-villas, Overton-road, Brixton, S.W.
Aug. 26, 1870	Hennell, Col. S., F.R.M.S., Ventnor-villa, Ventnor, Isle of Wight.
June 26, 1868	Henry, A. H., 49 Queen's-garden, Hyde-park, W.
June 26, 1874	Hewitt, W. W., F.R.M.S., 5 Torriano-gardens, Camden-road, N.W.
May 22, 1868	Hicks, J. J., 8 Hatton-garden, E.C.
Dec. 17, 1869	Hill, D. W., 78 Highbury New-park, N.
Sept. 24, 1869	Hilton, J. D., M.D., Upper Deal, Deal, Kent.
Sept. 28, 1866	Hind, F. H. P., Bartholomew-house, Bartholomew-lane, E.C.

Date of Election.	
May 22, 1874	Hind, George, 244 High Holborn, W.C.
May 24, 1872	Hinton, Ernest, 42 Grafton-street, Seven Sisters-road, Holloway, N.
Aug. 26, 1870	Hirst, John, jun., F.R.M.S., Dobcross, near Manchester.
Aug. 4, 1865	Hislop, W., F.R.A.S., High-street, Tunbridge-wells.
Dec. 23, 1870	Histed, Edward, James-street, Brighton.
Oct. 26, 1866	Holdernesse, W. B., 12 Park-street, Windsor.
April 26, 1867	Hooton, C., 3 Horningston-villas, Junction-rd., N.
May 22, 1868	Hopkinson, J., F.R.M.S., 8 Lawn-road, Haverstock-hill, N.W.
Oct. 26, 1866	Horncastle, H., Whitemoor, near Ollerton, Notts.
June 25, 1869	Houghton, W., Walthamstow, E.
May 22, 1874	Hovenden, C. W., 95 City-road, E.C.
April 26, 1867	Hovenden, F., F.R.M.S., Glenlea, Thurlow-park-road, Dulwich, S.E.
Feb. 25, 1870	Hudleston, W. H., J.P., F.G.S., 23 Cheyne-walk, S.W.
Jan. 26, 1872	Hudson, Robert, F.R.S., F.R.M.S., Clapham-common, S.W.
Dec. 28, 1866	Hunt, W. H. B., F.R.M.S., 23 Eversholt-street, Oakley-square, N.W.
Nov. 24, 1871	Hurdell, Charles, 9 North Audley-street, W.
July 25, 1873	Hurst, John Thomas, The War-office, Whitehall, S.W.
Nov. 25, 1870	Hutton, Rev. Wyndham M., Lezayre-vicarage, Ramsey, Isle of Man.
May 24, 1867	Ingpen, John E., F.R.M.S. (*Hon. Secretary*), 7 The Hill, Putney, S.W.
June 23, 1871	Isaac, Thomas, Maldon, Essex.
Aug. 22, 1873	Israel, S., 1 The Crescent, America-square, E.C.
Feb. 23, 1872	Izod, Theodore Chas., 10 Grange-villas, Grange-road, Upper Clapton, E.
Dec. 17, 1869	Jackson, B. D., F.R.M.S., 30 Stockwell-road, S.W.
July 24, 1868	Jackson, F. R., Culver-cottage, Slindon, Arundel, Sussex.

Date of Election.	
June 14, 1865	Jaques, Edward, F.R.M.S., 5 Hargrave-park-road, Upper Holloway, N.
Jan. 27, 1871	Jefferson, Henry, Eldon-house, Clapham-common, S.W.
April 23, 1869	Jefferson, Thomas, 3 Church-street, Lower Edmonton.
Feb. 28, 1873	Jenkins, J. W., 1 St. John's-hill, Wandsworth, S.W.
July 24, 1868	Jennings, Rev. Nathaniel, M.A., F.R.A.S., 66 Avenue-road, Regent's park, N.W.
Jan. 25, 1867	Johnson, John A., 15 Wellington-road, Stoke Newington, N.
Feb. 24, 1871	Johnson, M. Hawkins, F.G.S., 379 Euston-road, N.W.
Mar. 24, 1871	Johnstone, James, jun., 14 Lordship-park, Green-lanes, N.
Oct. 25, 1872	Jones, E. W., F.R.A.S., F.R.M.S., 53 Cowley-road, North Brixton, S.W.
Feb. 28, 1873	Jones, Geo. J., 73 High-street, Lymington, Hants.
Nov. 25, 1870	Jones, Lieut.-Colonel Lewis, United Service Club, Pall-mall, S.W.
May 23, 1873	Jones, Captain Loftus F., United Service Club, Pall-mall, S.W.
May 22, 1874	Jones, W. W., 14 Lancaster-street, Lancaster-gate, Hyde-park, W.
May 23, 1873	Karop, Geo. C., 54 Patshull-road, Camden-town, N.W.
Oct. 26, 1866	Kemp, Robert, 60 Windsor-road, Upper Holloway, N.
May 23, 1873	Kennell, W. H., Hornton cottage, Campden-hill, W.
Oct. 26, 1866	Kent, W. S., F.R.M.S., F.Z.S., Wentworth-house, Church-street, Stoke Newington, N.
Aug. 23, 1867	Kiddle, Edward, The War Office, Pall-mall, S.W.
Mar. 19, 1869	Kilsby, Thomas W., 4 Brompton-villas, Edmonton.
July 7, 1865	King, G. H., 190 Great Portland-street, W.
July 22, 1870	King, Henry, 65 Myddelton-square, E.C.

Date of Election.

Dec. 23, 1870	King, Robert, F.R.M.S., Fern-house, Upper Clapton, E.
April 26, 1867	Kirk, Joseph, 11 Blossom-st., Norton Folgate, E.
Feb. 28, 1873	Kitsell, Francis J., 7 John's-terrace, Latymer-road, W.
June 24, 1870	Knaggs, Henry G., M.D., 49 Kentish-town-road, N.W.
Oct. 24, 1873	Knight, John Mackenzie, 11 Burdett-road, Bow-road, E.
Mar. 28, 1873	Lacy, Brooke V., London-bridge, S.E.
Nov. 25, 1870	Ladd, Wm., F.R.A.S., F.R.M.S., 12 Beak-street, Regent-street, W.
July 27, 1866	Lambert, T. J., 151 Highbury New-park, N.
Nov. 23, 1866	Lambert, W., 4 New Basinghall-street, E.C.
Aug. 24, 1866	Lampray, John, F.R.G.S., 16 Camden-square, N.W.
Mar. 22, 1867	Lancaster, Thos., Bownham-house, Stroud, Gloucestershire.
Dec. 28, 1866	Langrish, H., 250 Pentonville-road, N.
April 26, 1872	Law, Rev. William, Marston Trussell, Market Harborough.
June 25, 1869	Layton, Charles E., 8 Upper Hornsey-rise, N.
Aug. 28, 1868	Leaf, C. J., F.L.S., F.R.M.S., &c. (*President of the Old Change Microscopical Society*), Old Change, E.C.
Mar. 19, 1869	Lee, Henry, F.L.S., F.R.M.S., &c., The Waldrons, Croydon.
Mar. 27, 1874	Leefe, Frederick Ewbank, 289, Goswell-road, E.C.
Oct. 25, 1867	Leifchild, J. R., M.A., 42 Fitzroy-street, Fitzroy-square, W.
Sept. 22, 1865	Leighton, W. H., 2 Merton-place, Chiswick, W.
June 25, 1869	Lemmon, Benj., 61 Hungerford-road, Islington, N.
July 25, 1873	Le Pelley, C., 27 Underwood-street, Shepherdess-walk, Hoxton, N.
May 28, 1869	Letts, Edmund A., South-view, Black Gang, Isle of Wight.
July 26, 1872	Levien, Charles N., 3 Great Tower-street, E.C.
Mar. 22, 1867	Lewinsky, John, 13 Frith-street, Soho, W.

Date of Election.

April 27, 1866	Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 1 Lowndes-terrace, Knightsbridge, S.W.
Nov. 24, 1871	Lewis T. Preston, 8 The Crescent, Norwich.
June 26, 1868	Lindley, W., jun., Kidbrook-terrace, Blackheath, S.E.
Nov. 24, 1865	Loam, Michael, Hampton, Middlesex.
May 26, 1871	Locke, John, 65 Camden-st., Camden-town, N.W.
April 23, 1869	Long, Henry, 90 High-street, Croydon.
Nov. 24, 1865	Lovibond, J. W., F.R.M.S., St. Anne-street, Salisbury.
Sept. 22, 1865	Lovick, T., Board of Works, Spring-gardens, S.W.
May 28, 1869	Lowe, Henry W., Heathfield, Sydenham-hill, S.E.
Dec. 18, 1868	LOWNÈ, BENJAMIN THOMPSON, M.R.C.S., F.R.M.S. (*Vice-President*), 49 Colville-gardens, W.
April 27, 1866	Loy, W. T., F.R.M.S., 9 Garrick-chambers, Garrick-street, W.C.
Jan. 24, 1873	McBride, Francis J., 47 Windsor-terrace, City-road, E.C.
Jan. 24, 1868	Macdonald, J., M.D., 68 Up. Kennington-lane, S.E.
Nov. 23, 1866	McIntire, S. J., F.R.M.S., 22 Bessborough-gardens, S.W.
Jan. 26, 1872	McKechnie, J. Hamilton, M.D., 16 Princes-street, Cavendish-square, W.
May 22, 1868	McVean, W., 50 Lower Tulse Hill, S.W.
June 26, 1874	Magor, Thomas, M.D., Myddelton-road, Hornsey, N.
May 22, 1874	Manly, Dr., Thatched House Club, St. James'-st., S.W.
Sept. 27, 1872	Manning, His Grace the Archbishop, Francis-st., Vauxhall Bridge-road, S.W.
June 14, 1865	Marks, E. (*Assistant-Secretary*), Laburnum-cottage, Middle-lane, Crouch End, N.
Mar. 22, 1872	Marquand, Ernest D., 2 Newport-villas, Finchley, N.
June 26, 1868	Martin, James, 110 Regent-street, W.
Dec. 27, 1867	Martinelli, A., 106 Albany-street, N.W.
Oct. 25, 1867	Marwood, W. G. H., 68 Downham-road, Kingsland, N.

Date of Election.	
June 27, 1873	Mason, Thomas, 3 Holborn Viaduct, E.C.
April 26, 1867	Matthews, G. K., St. John's-lodge, Beckenham, Kent.
Oct. 26, 1866	MATTHEWS, JOHN, M.D., F.R.M.S. (*President*), 4 Mylne-street, Myddelton-square, E.C.
June 28, 1867	Matthews, Peter, L.D.S., F.Z.S., F.R.M.S., 11 Welbeck-street, W.
Sept. 24, 1869	Matthews, William, 374 Camden-road, N.
May 26, 1871	May, John William, F.R.M.S., Arundel-house, Percy-cross, Fulham, S.W.
Feb. 27, 1874	May, Lewis J., 371, Holloway-road, N.
Feb. 28, 1873	Mayhew, A. F., 12 Crescent-terrace, Pimlico, S.W.
Mar. 22, 1867	Meacher, John W., 10 Hillmarten-road, Camden-road, N.
May 22, 1874	Meates, Edgar A., 83, Cambridge-street, Pimlico, S.W.
May 27, 1870	Medlock, Henry, M.D., 22 Tavistock-square, W.C.
May 22, 1874	Messenger, G. A., 21 Glengall-grove, Old Kent-rd., S.E.
Dec. 18, 1868	Mestayer, Richard, F.L.S., F.R.M.S., 7 Buckland-crescent, Belsize-park, N.W.
June 26, 1868	Milledge, Alfred, 4 Upper Winchester-road, Stanstead-road, Forest-hill, S.E.
Sept. 28, 1866	Miller, Benj., M.R.C.S., F.R.M.S., 4 Denmark-hill, S.E.
July 7, 1865	Millett, F. W., 21 Duncan-terrace, Islington, N.
Feb. 28, 1873	Mills, Chas., 21, Courtney-rd., Highbury New-park, N.
May 25, 1866	Moginie, W., F.R.M.S., 14 Riding-house-street, W.
Mar. 27, 1868	Moore, Daniel, M.D., Hastings-lodge, Victoria-road, Upper Norwood, S.E.
Jan. 23, 1874	Moreland, Richard, Jun., Old-street, E.C.
Oct. 27, 1865	Morrieson, Colonel R., F.R.M.S., Oriental Club, Hanover-square, W.
April 24, 1868	Mummery, J. Rigden, F.L.S., F.R.M.S., 10 Cavendish-place, W.
April 24, 1868	Mummery, J. Howard, 10 Cavendish-place, W.
Dec. 18, 1868	Mundie, George, M.R.C.S., 93 Richmond-road, Dalston, E.

Date of Election.

Jan. 25, 1867	Murray, R.C., 69 Jermyn-street, St. James's, S.W.
Mar. 23, 1866	Nation, W. J., 30 King-square, Goswell-road, E.C.
Mar. 24, 1871	Nelson, James, 2 Durham-pl., Lambeth-rd., S.E.
Jan. 26, 1872	Newton, Edwin Tulley, F.G.S., Geological Museum, Jermyn-street, S.W.
Jan. 23, 1874	Newton, Henry Edward, Woolsthorpe, The Avenue, Gipsy Hill, Norwood, S.E.
July 7, 1865	Nicholson, D., 51 St. Paul's-churchyard, E.C.
July 26, 1872	Nicoll, Geo., jun., 4 Kingston-villas, Buckhurst-hill, Essex.
May 22, 1874	Nixon, Philip Charles, 23 Crutched-friars, E.C.
Sept. 23, 1870	O'Connor, Rochfort, 9 St. Martin's-road, Stockwell, S.W.
May 26, 1871	Oriel, Chas. F., Oak-villa, Mattock-lane, Ealing, W.
Dec. 27, 1867	Oxley, F., 8 Crosby-square, Bishopsgate, E.C.
May 22, 1874	Palmer, Thomas, Elmstead, near Chislehurst.
Nov. 27, 1868	Parker, T., 10 Brunswick-square, Camberwell, S.E.
Oct. 27, 1871	Parsons, Fred. Anthony, 18 London-street, City, E.C.
June 25, 1869	Pass H., 11 Spring-terrace, Wandsworth-road, S.W.
May 26, 1871	Paxton, Rev. W. Archibald, M.A., Otterden Rectory, Faversham, Kent.
Feb. 27, 1874	Payne, William, F.R.M.S., The Keep, Forest Hill, S.E.
May 22, 1874	Pearce, George Alonzo Creechy, B.A., M.B., B.C.N., Priory Chambers, Crutched Friars, E.C.
May 24, 1867	Pearce, George, 1 Queen's-terrace, Camden-road-villas, N.W.
Feb. 23, 1872	Pearse, W. E. Grindley, L.R.C.P., 24 Bessborough-gardens, S.W.
May 24, 1867	Pearson, John, 212 Edgware-road, W.
Nov. 26, 1869	Perken, Edmund, 24 Hatton-garden, E.C.
May 26, 1871	Pett, Edward Pattison, Romney-villa, Elfra-road, Tulse-hill, S.W.
Oct. 27, 1865	Pickard, J. F., 1 Bloomsbury-street, W.C.

Date of Election.

Dec. 23, 1870	Pigott, G. W. Royston, M.A., M.D., F.R.S., &c., 2 Lansdown-crescent, Kensington-park, W.
Jan. 22, 1869	Pillischer, M., F.R.M.S., 88 New Bond-street, W.
Nov. 24, 1871	Pitts, Fred., Harvard-house, St. John's-hill, Clapham, S.W.
June 25, 1869	Pocock, Lewis, Jun., 70 Gower-street, W.C.
Nov. 23, 1866	Potter, G., F.R.M.S., 42 Grove-road, Upper Holloway, N.
June 22, 1866	Powe, I., St. John's, Richmond, Surrey.
May 25, 1866	Powell, Hugh, F.R.M.S., 170 Euston-road, N.W.
Jan. 24, 1873	Powell, Jas. J., 43 Burton-road, Brixton, S.W.
July 7, 1865	Powell, Thomas, 18, Doughty-street, Mecklenberg-square, W.C.
July 24, 1874	Powell, Thomas Henry, 7, Poultry, E.C.
Oct. 26, 1866	Praill, Edward, 39 Mornington-road, N.W.
Dec. 27, 1867	Preston, H. B., 1 Devonshire-road, Liverpool.
June 24, 1870	Preston, Francis W. H., 30 Warwick-gardens, Kensington, W.
Oct. 25, 1872	Price, W. H., 1 The Terrace, Kennington-park, S.E.
Feb. 26, 1869	Prichard, Thomas, M.D., Abbington Abbey, Northampton.
June 27, 1873	Priest, B. W., 22 Parliament-street, S.W.
Nov. 27, 1868	Pritchett, Benjamin, 131 Fenchurch-street, E.C.
July 26, 1867	Pritchett, Francis, 131 Fenchurch-street, E.C.
April 23, 1869	Quekett, Alfred J. S., 13 Delamere-crescent, Westbourne-square, W.
April 23, 1869	Quekett, Arthur Edwin, 13 Delamere-crescent, Westbourne-square, W.
April 23, 1869	Quekett, Rev. William, The Rectory, Warrington.
Feb. 23, 1866	Quick, George E., 109 Long-lane, Bermondsey, S.E.
Oct. 26, 1866	Rabbits, W. T., Selwood, Mayow-road, Forest-hill, S.E.
Nov. 23, 1866	Radermacher, J. J., 21 Tregunter-road, The Boltons, Brompton, S.W.
Sept. 24, 1869	Radcliffe, J. D., 93 Albion-road, Dalston, E.
Oct. 26, 1866	Ramsbotham, J. M., M.D., 15 Amwell-street, Pentonville, E.C.

Date of Election.

Oct. 26, 1866	Ramsden, Hildebrand, M.A. Cant., F.L.S., F.R.M.S., Forest-rise, Walthamstow, E.
Aug. 28, 1868	Rance, T. G., Widmore-lane, Bromley, Kent.
May 22, 1868	Rawles, W., 64 Kentish-town-road, N.W.
Oct. 28, 1870	Rean, Walter, Woodstock-road, Poplar, E.
June 27, 1873	Reeve, Fredk., 37 Fentiman-rd., Clapham, S.W.
July 7, 1865	Reeves, W. W., F.R.M.S., 37 Blackheath-hill, Greenwich, S.E.
May 22, 1874	Reid, Wm. Wardlaw, 16 Warwick-place, Peckham Rye, S.E.
May 26, 1871	Richards, Edward, F.R.M.S., 289 Camberwell New-road, S.E.
Jan. 24, 1868	Richardson, C. J., 44 Duncan-terrace, Islington, N.
Dec. 22, 1865	Richardson, C. T., M.D., 36 Dorset-square, N.W.
Mar. 25, 1870	Richardson, Thomas Hyde, 1 Belgrave-villas, Holmesdale-road, Selhurst, S.E.
Feb. 23, 1866	Rixon, F., F.R.M.S., Loats-rd., Clapham-pk., S.W.
June 25, 1869	Roberts, John H., F.R.C.S., F.R.M.S., 20 New Finchley-road, St. John's-wood, N.W.
April 26, 1872	Roberts, S. Hackett, 355 Walworth-road, S.E.
May 22, 1868	Rogers, John, F.R.M.S., Elm-avenue, New Basford, near Nottingham.
June 26, 1874	Rogers, John Robert, 4, Cuba-terrace, Junction-road, Upper Holloway, N.
Oct. 26, 1866	Rogers, Jos. R., 12 Bellefield-terrace, Bellefield-road, Stockwell, S.W.
Oct. 26, 1866	Rogers, Thomas, F.R.M.S., Mortlock-house, Loughborough-road, Brixton, S.W.
Mar. 22, 1872	Rolfe, Charles Spencer, 20 Highbury-place, Highbury, N.
May 22, 1868	Roper, F. C. S., F.L.S., F.G.S., F.R.M.S., Palgrave-house, Eastbourne, Sussex.
July 24, 1868	Rowe, James, Jun., M.R.C.V.S., 65 High-street, Marylebone, W.
Oct. 26, 1866	Rowlett, John, 10 Crozier-street, S.E.
June 14, 1865	Ruffle, G. W. (*Hon. Curator*), 131 Blackfriars-road, S.E.
July 24, 1874	Rushton, Wm., 26, Park-street, Islington, N.
Oct. 27, 1865	Russell, James, 4 Lansdowne-terrace, London-fields, Hackney, E.

Date of Election.	
Oct. 26, 1866	Russell, Joseph, Cumberland-lodge, Brixton-hill, S.W.
May 22, 1868	Russell, Thomas D., 21 Park-road, West Dulwich, S.E.
Feb. 22, 1867	Rutter, H. Lee, 1 St. Barnabas-villas, Lansdowne-circus, South Lambeth, S.W.
May 23, 1873	Salkeld, Lt.-Colonel Joseph C., F.R.C.S., F.R.M.S., 29 St. James's-street, S.W.
Dec. 17, 1869	Salmon, John, 24 Seymour-st., Euston-sq., N.W.
Dec. 17, 1869	Sanders, Gilbert, Brockley-on-the-Hill, Monkstown, Dublin.
July 26, 1872	Sargent, J., Jun., Fritchley, Near Derby.
July 26, 1872	Sarll, John, De Beauvoir House, Englefield-rd., N.
May 22, 1867	Scatliff, John Parr, M.D., 132 Sloane-street, S.W.
May 24, 1872	Schloesser, Ernest, 9 College-hill, Cannon-st., E.C.
May 24, 1872	Sequeira, H. L., M.R.C.S., 1 Jewry-street, Aldgate, E.C.
July 27, 1868	Sewell, Richard, Prince's road, Lambeth, S.E.
Oct. 22, 1869	Shaw, Wm. Forster, 50 Threadneedle-street, E.C.
Jan. 22, 1869	Sheehy, William H., M.D., 4 Claremont-square, N.
May 24, 1872	Sheehy, W. H. Podmore, 4 Claremont-square, N.
May 26, 1871	Sigsworth, J. C., F.R.M.S., 18 Loraine Road, Upper Holloway, N.
June 27, 1873	Simmonds, Joseph E., 32 Cornwall-street, Fulham, S.W.
Aug. 23, 1867	Simmons, James J., L.D.S., 18 Burton-crescent, W.C.
Mar. 27, 1868	Simson, Thos., The Laurels, Courtyard, Eltham.
May 28, 1869	Sketchley, H. G., 10 Ampthill-square, N.W.
Dec. 28, 1866	Slade, J., 100 Barnsbury-road, N.
Mar. 22, 1872	Smart, Harry, 11 Paragon-terrace, Hackney, E.
Oct. 23, 1868	Smart, William, 27 Aldgate, E.
May 25, 1866	Smith, Alpheus (*Hon. Librarian*), 42 Choumert-road, Rye-lane, Peckham, S.E.
Mar. 25, 1870	Smith, Francis Lys, 3 Grecian-cottages, Crown-hill, Norwood, S.E.
June 27, 1873	Smith, G. J., 2 Foster-lane, Cheapside, E.C.
Oct. 26, 1868	Smith, H. Ambrose, 2 King William-st., City, E.C.

Date of Election.

June 26, 1868	Smith, James, F.L.S., F.R.M.S., 11 Willow-cottages, Canonbury, N.
Dec. 23, 1870	Smith, Joseph A., London and County Bank, Newington, S.E.
May 22, 1874	Smith, Roland D., York-house, Chatteris, Cambridgeshire.
June 24, 1870	Smith, William, 18 Highfield-road, Brompton, S.W.
Feb. 28, 1873	Smith, W. Lepard, Southfield-house, Watford.
Aug. 23, 1872	Smith, W. S., 30 Loraine-road, Upper Holloway, N.
April 24, 1868	Snellgrove, W., 22 Surrey-square, S.E.
Sept. 22, 1865	Southwell, C., 44 Princes-street, Soho, W.
Dec. 18, 1868	Sowerby, D., 38 Albert-road, Dalston, E.
May 22, 1874	Spencer, James, South-street, Greenwich, S.E.
May 22, 1868	Spencer, John, Brook's Bank, 81 Lombard-street, City, E.C.
Nov. 22, 1872	Spencer, Thomas, F.G.S., F.R.M.S., 32 Euston-square, N.W.
Mar. 24, 1865	Starling, Benjamin, 11 Gray's-inn-square, W.C.
Feb. 23, 1872	Stevens, C. R., 7 Ashby-road, Canonbury, N.
Aug. 24, 1866	Steward, J. H., F.R.M.S., 406 Strand, W.C.
May 23, 1873	Steward, James H.C., 406 Strand, W.C.
Mar. 19, 1869	Stokes, Frederick, 2 Milton-villas, Milton-road, Dulwich, S.E.
Oct. 27, 1871	Stuart, David John, 53 Ferntower-road, Highbury-new-park, N.
July 7, 1865	Suffolk, W. T., F.R.M.S., Claremont-lodge, Park-street, Camberwell, S.E.
June 27, 1873	Suter, Edward D., Kent-lodge, Douglas-road North, Canonbury, N.
June 24, 1870	Swain, Ernest, 89, Ladbroke-road, W.
Nov. 22, 1867	Swainston, J. T., 14 Loraine-place, Holloway, N.
Nov. 24, 1865	Swansborough, E., 20 John-st, Bedford-row, W.C.
Dec. 18, 1868	Swift, James, 43 University-street, W.C.
Nov. 25, 1870	Tafe, John Forwood, Fernlea, King Edward-road, Victoria-park, E.

Date of Election.	
May 22, 1868	Tatem, J. G., Russell-street, Reading.
Aug. 25, 1871	Taverna, The Count Joseph, Symond's Hotel, Brook-street, Grosvenor-square, W.
Jan. 23, 1874	Taylor, John Ellor, Ipswich.
Dec. 22, 1865	Terry, J., 109 Borough-road, S.E.
Aug. 23, 1872	Terry, Thomas, 5 Austin-friars, E.C.
July 23, 1869	Thin, James, Ormiston-lodge, Claremont-place, Brixton-road, S.W.
Feb. 24, 1871	Thornthwaite, W. H., jun., 3 Holborn-viaduct, E.C.
Jan. 24, 1868	Tomkins, Samuel Leith, 26 Buckland-crescent, Belsize-park, N.W.
June 23, 1871	Topping, Amos, 28 Charlotte-street, Caledonian-road, N.
July 26, 1872	Townsend, John Sumsion, F.R.M.S., 59, London-road, Croydon.
April 26, 1873	Tozer, Edward, Ivy-lodge, Woodford, Essex.
July 24, 1868	Tulk, John A., M.D., Spring-grove, Isleworth.
July 26, 1867	Turnbull, Joseph, Laurel House, North-hill, High-gate, N.
June 25, 1869	Turner, R. D., Chafford, Tunbridge.
Nov. 28, 1873	Underwood, Charles Cradock, 13 Holles-street, Cavendish-square, W.
July 27, 1866	Veitch, Harry, F.H.S., The Royal Exotic Nursery, King's-road, Chelsea, S.W.
May 22, 1874	Wadmore, Ernest, 2 Oakley-road, Essex-road, Islington, N.
Feb. 23, 1866	Walker, A., M.D., 17 Throgmorton-street, E.C.
April 24, 1874	Walker, Enoch, 4 Banbury-terrace, South Hackney, E.
May 28, 1869	Walker, Henry, 100 Fleet-street, E.C.
Feb. 27, 1874	Walker, John C., 14 Hilldrop-road, Camden-road, N.
July 25, 1873	Walker, John Stringer, Warwick-road, Up. Clapton, E.

Date of Election.	
June 26, 1868	Walker, J. W., Fairfield-house, Watford.
Dec. 18, 1868	Waller, Arthur, F.R.M.S., 11 Aberdeen-park, Highbury, N.
May 22, 1868	Waller, J. G., 68 Bolsover-street, Portland-road, W.
Oct. 27, 1865	Wallis, George, South Kensington Museum, S.W.
July 24, 1874	Wallis, James, 22 Cranmer-road, Brixton-road, S.E.
Aug. 26, 1870	Warburton, Samuel, Merton-villa, New-road, Lower Tooting, S.W.
Dec. 22, 1871	Ward, Daniel, 26 Coleman-street, Woolwich, S.E.
Nov. 22, 1867	Ward, F. H., M.R.C.S., F.R.M.S., Springfield-house, near Tooting, S.W.
Dec. 18, 1868	Warner, Alfred, 6 South-terrace, Hatcham-park-road, New-cross, S.E.
Feb. 26, 1869	Warner, William, 51 Bookham-street, New North-road, N.
May 25, 1866	Warrington, H. R., 7 Royal Exchange, Cornhill, E.C.
Oct. 27, 1865	Watkins, C. A., 10 Greek-street, Soho, W.
Oct. 25, 1872	Watkins, J., L.C.P., Union-street, Deptford, S.E.
Dec. 28, 1866	Way, T. E., 65 Wigmore-street, W.
July 24, 1874	Webb, C. E., Nildwood-lodge, North-end, Hampstead, N.W.
Dec. 22, 1871	Webber, John, Limes-villas, Croxted-road, Dulwich, S.E.
May 24, 1867	Weeks, A. W. G., 18 Gunter's-grove, Chelsea, S.W.
Dec. 28, 1866	Wheldon, W., 58 Great Queen-street, W.C.
Dec. 27, 1872	White, Charles E., 32 Belgrave-road, S.W.
April 23, 1869	WHITE, CHARLES FREDERICK, F.R.M.S. (*Vice-President*), 42 Windsor-road, Ealing, W.
Feb. 26, 1868	White, Francis W., 2 Brunswick-cottages, Gipsy-hill, S.E.
May 22, 1868	WHITE, T. CHARTERS, M.R.C.S., F.R.M.S. (*Vice-President*), 32 Belgrave-road, S.W.
July 25, 1873	White, Walter, Litcham, Norfolk.
May 24, 1867	White, W., Cawston, Sandown, Isle of Wight.
May 23, 1873	Whitmore, John, M.D., 15 Wimpole-street, W.

Date of Election.	
July 24, 1868	Wight, James F., F.R.M.S., Gatcombe-villa, Croxted-road, West Dulwich, S.E.
Mar. 24, 1871	Williams, George, 6 St. John's-park, Upper Holloway, N.
Oct. 24, 1873	Williams, John R., 13 Bouverie-road, Stoke Newington, N.
Oct. 28, 1870	Williams, Martin G., 2 Highbury-crescent, N.
July 28, 1871	Williams, Robert Pakenham, 18 Brunswick-road, Upper Holloway, N.
Feb. 28, 1873	Williams, Wm. A. B., 23 Highbury-place, N.
Jan. 25, 1867	Willsworth, H., 7 Whittington-terrace, Upper Holloway, N.
Feb. 23, 1866	Wilshin, J., 12 Totford-place, Neckinger, Bermondsey, S.E.
Feb. 22, 1867	Wilson, Frank, 110, Long-acre, W.C.
Feb. 27, 1874	Wilson, William, 420 Holloway-road, N.
April 24, 1868	Withall, Henry, 1 The Elms, St. John's-road, Brixton, S.W.
Aug. 27, 1869	Woods, W. Fell, 1 Park-hill, Forest-hill, S.E.
Oct. 25, 1867	Worthington, Richard, Champion-park, Denmark-hill, S.E.
June 27, 1873	Wrey, George E. B., Addington-house, Addington-road, Reading.
Jan. 23, 1874	Wright, Cecil H., 27 Wardour-street, W.
Nov. 23, 1866	Wright, Edward, 89 Shepherdess-walk, E.C.
Aug. 4, 1865	Wyatt, C. C., 9 North Audley-street, W.
Oct. 26, 1866	Yeats, Christopher, Mortlake, Surrey, S.W.

NOTICE.

Members are reminded that the Subscriptions for the year commencing July 1st, 1874, and ending June 30th, 1875, are now due.

They are requested to send the amount by Cheque or Post Office Order (not Stamps) to the Treasurer, Mr. Robt. Hardwicke, 192, Piccadilly, W., where Subscriptions can be received any day between 10 and 4.

Any member of the Club changing his address, will oblige by communicating his new direction to the Secretary without delay.

RULES.

I.—That "The Quekett Microscopical Club" hold its meetings at University College, Gower Street, on the fourth Friday Evening in every month, at Eight o'clock precisely, or at such other time or place as the Committee may appoint.

II.—That the business of the Club be conducted by a Committee consisting of the President, four Vice-Presidents, the Treasurer, the Honorary Secretary, the Honorary Secretary for Foreign Correspondence, and twelve other members,—six to form a quorum. That the President, Vice-Presidents, Secretaries, and the four senior members of the Committee (by election) retire annually, but be eligible for re-election. That the Committee may appoint a stipendiary Assistant Secretary, who shall be subject to its direction.

III.—That at the ordinary Meeting in June, nominations be made of Candidates to fill the offices of Vice-Presidents and vacancies on the Committee. That such nominations be made by resolutions duly moved and seconded, no Member being entitled to propose more than one Candidate. That in the event of such nominations exceeding one half more than the number of vacant offices, the Candidates be reduced by show of hands to such proportion. That the President, Treasurer, Honorary Secretary, and Honorary Secretary for Foreign Correspondence be nominated by the Committee. That a list of all nominations made as above be printed in alphabetical order upon the ballot paper. That at the Annual General Meeting in July all the above officers be elected by ballot from the candidates named in the lists, but any member is at liberty to substitute on his ballot-paper any other name or names in lieu of those nominated for the offices of President, Treasurer, Honorary Secretary, and Honorary Secretary for Foreign Correspondence.

IV.—That in the absence of the President and Vice-Presidents the Members present at any ordinary Meeting of the Club elect a Chairman for that evening.

V.—That every Candidate for Membership be proposed by two or more Members, who shall sign a certificate (see Appendix) in recommendation of him—one of the proposers from personal knowledge. The certificate shall be read from the chair, and the Candidate therein recommended ballotted for at the following Meeting. Three black balls to exclude.

VI.—That the society include not more than twenty Honorary Members, elected by the Members by ballot upon the recommendation of the Committee.

VII.—That the Annual Subscription be Ten Shillings, payable in advance on the 1st of July, but that any Member elected in May or June be exempt from subscription until the following July. That any Member desirous of compounding for his future subscription may do so at any time by payment of the sum of Ten Pounds; all such sums to be duly invested in such manner as the Committee shall think fit. That no person be entitled to the full privileges of the Club until his subscription shall have been paid; and that any Member omitting to pay his subscription six months after the same shall have become due (two applications in writing having been made by the Treasurer) shall cease to be a Member of the Club.

VIII.—That the accounts of the Club be audited by two Members, to be appointed at the ordinary Meeting in June.

IX.—That the Annual General meeting be held on the fourth Friday in July, at which the Report of the Committee on the affairs of the Club, and the Balance Sheet duly signed by the Auditors shall be read. Printed lists of Members nominated for election as President, Vice-Presidents, Treasurer, Secretaries, and Members of the Committee having been distributed, and the Chairman having appointed two or more Members to act as Scrutineers, the Meeting shall then proceed to ballot. If from any cause these elections, or any of them, do not take place at this Meeting, they shall be made at the next ordinary Meeting, of the Club.

X.—That at the ordinary Meetings the following business be transacted:—The minutes of the last Meeting shall be read and confirmed; donations to the Club since the last Meeting announced

and exhibited; ballots for new Members taken; papers read and discussed; and certificates for new Members read; after which the Meeting shall resolve itself into a conversazione.

XI.—That any Member may introduce a Visitor at any ordinary meeting, who shall enter his name with that of the Member by whom he is introduced, in a book to be kept for the purpose.

XII.—That no alteration be made in these Laws, except at an Annual General Meeting, or a Special General Meeting called for that purpose; and that notice in writing of any proposed alteration be given to the Committee, and read at the ordinary Meeting at least a month previous to the Annual or Special Meeting, at which the subject of such alteration is to be considered.

APPENDIX.

Form of Proposal for Membership in Quekett Microscopical Club.

Mr.

of

being desirous of becoming a Member of this Club, we beg to recommend him for election.

(on my personal knowledge).

This Certificate was read 187

The Ballot will take place 187

RULES FOR THE EXCHANGE OF SLIDES.

I. That all Slides be deposited with the Exchange Committee.

II. That not more than two similar Slides be placed in the Exchange Box at one time by any one Member.

III. That the Slides be classified by the Committee into Sections, numbered according to quality.

IV. Members to select from the class in which their Slides are placed, at the ordinary meetings of the Club.

V. Members may leave the selection to the Exchange Committee, if they prefer it.

VI. Slides once exchanged cannot be exchanged again.

VII. A Register shall be kept, in which the Slides deposited shall be entered and numbered, with the date of receipt, and in which exchanges shall also be noted.

VIII.—All expenses incurred in the transmission of Slides or in correspondence respecting them, to be borne by the Member on whose account such charges may be incurred.

Parcels may be addressed—

Mr. John E. Ingpen
192, Piccadilly,
London, W.
[Exchange.]

Note.—As much inconvenience frequently arises from the breakage of Slides in transmission through the Post, the following method is recommended:—Pack the Slides in a small wooden box, which can be obtained of any Optician, tie it securely with string and attach a slip of parchment to one end, sufficiently large to receive the Postage Stamps, Address, and local Post-office Stamps during transmission.

If paper be used as a wrapper to the box, the colour should be *black*.

When twelve or more Slides are sent, they should be packed in a racked box and forwarded by Railway.

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB,

AT

UNIVERSITY COLLEGE, GOWER STREET, LONDON.

1874.—August	14	....	28
September	11	....	25
October	9	....	23
November	13	....	27
December	11	....	*
1875.—January	8	....	22
February	12	....	26
March	12	....	†
April	9	....	23
May	14	....	28
June	11	....	25
July	9	....	23

* Dec. 25th, 1874.—Christmas Day—no Meeting.

† Mar. 26th, 1875.—Good Friday— ditto

The Ordinary Meetings are held on the *fourth* Friday in each month:—business commences at 8 o'clock p.m.

The Meetings on the *second* Friday in each month are for Conversation and Exhibition of Objects only, from 7 to 9.30 p.m.

The Annual General Meeting will be held on July 23rd, 1875, at 8 o'clock, for Election of Officers and other business.

Offices, 192, Piccadilly, W.

QUEKETT MICROSCOPICAL CLUB.

EXCURSIONS, 1874.

April 11th	SNARESBROOK. To meet at Fenchurch Street Station, G.E.R.
April 25th	TORRINGTON PARK (for TOTTERIDGE), returning by MILL HILL. To meet at King's Cross Station, G.N.R.
May 9th	ESHER. To meet at Waterloo Station (Main Line).
May 23rd	CHISELHURST. To meet at Charing Cross Station.
June 6th	ELSTREE, returning by EDGWARE. To meet at St. Pancras Station, at 1.30 P.M.
June 13th	CATERHAM. To meet at Charing Cross Station.
June 19th	EXCURSIONISTS' ANNUAL DINNER. Arrangements will be duly announced.
July 4th	ADDLESTONE. To meet at Waterloo Station (Main Line).
July 13th	SOUTHEND, Day Excursion. To meet at Fenchurch Street Station, the first Train after 10 A.M.
July 25th	EAST END (for FINCHLEY COMMON), returning by SOUTHGATE. To meet at King's Cross Station.
Sept. 5th	BROMLEY (for KESTON). To meet at Holborn Viaduct Station.
Sept. 19th	DARTFORD (for DARENTH WOOD). To meet at Charing Cross Station.
Oct. 3rd	BARNES. To meet at Waterloo Station (Richmond Line).
Oct. 17th	WANDSWORTH COMMON. To meet at Clapham Junction, at 3 P.M.

The time of departure from Town, unless otherwise specified, will be THE FIRST TRAIN AFTER TWO O'CLOCK.

F. W. Gay,
F. Oxley,
W. W. Reeves,
W. T. Suffolk,
Excursion Committee.

John E. Ingpen, Hon. Secretary.
Offices, 192, Piccadilly, W.

W. DAVY AND SON, PRINTERS, GILBERT STREET, W.

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